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ABSTRACT

This PhD thesis deals with the use of urban green space and understanding the various factors that influence this use. The main hypothesis is that most green spaces have the potential to be used more and that this dormant potential can be utilised if green space managers make the right choices in the planning and management of urban green space. However, to be able to make the right choices it is important to understand the factors that influence the use of urban green space, and much of this knowledge is currently lacking. The use of green space was investigated based on data from a national representative survey in Denmark (n=11 238), as well as a local survey in the City of Odense, Denmark (n = 1 305). In the City of Odense, detailed information on the available urban green space was also collected. Multiple logistic regression analyses were used to investigate the association between potential predictor factors and the use of urban green space, as well as physical activity in urban green space. A Latent Class Analysis was conducted to reveal clusters of users, and decay parameters were calculated to model the attractiveness of urban green space.

The results show that both individual factors and environmental factors are associated with the use of urban green space. Various individual factors such as age, education and having small children, are associated with the use of green space. This becomes even more evident when the respondents are grouped into five clusters that each have a distinct set of individual characteristics and a differentiated pattern of use. Distance, size, the number of features, and the number of experiences are four environmental factors that seem to affect use, and decay parameters for each of the four factors were used to construct a model for the attractiveness of urban green space. The attractiveness model was adapted for each of the five clusters of users.

Contrary to findings in other studies, distance does not seem to be a limiting factor for the majority of Danes, and many respondents in the City of Odense indicated that they were willing to go past their nearest green space to reach their most used green space. This indicates that a general strategy to provide green space closer to people might have limited effect in Denmark. Therefore, I recommend using locally adapted strategies in which a thorough analysis of both neighbourhood residents as well as available green space is included to reveal the true limiting factors. Within this project tools have been developed that can assist making this analysis.

RESUMÉ

Denne ph.d. afhandling handler om brug af byens grønne områder og forståelse af de faktorer der påvirker brugen. Hypotesen er, at de fleste grønne områder har potentiale til at blive brugt mere, og at dette potentiale kan udnyttes, hvis parkforvaltere fortager de rigtige valg når de planlæger og forvalter for byens grønne områder. For at kunne tage de rigtige valg, er det væsentlig at forstå de faktorer der påvirker brugen af byens grønne områder, og denne viden mangler i vid ustrækning. Brugen af byens grønne områder er undersøgt ved hjælp at et nationalt repræsentativt spørgeskema i hele Danmark (n=11 238), og et lokalt spørgeskema i Odense (n = 1 305). I Odense er detaljeret information om alle grønne områder også samlet ind. Der er brugt logistiske regressionsanalyser til at undersøge sammenhænge mellem potentielt forudsigende faktorer, brug af grønne områder og fysisk aktivitet i grønne områder. En Latent Class Analysis er lavet for at finde segmenter af brugere, og reduktionsparametre er beregnet til brug i en model for attraktiviteten af byens grønne områder.

Resultaterne viser sammenhæng mellem individuelle såvel som miljø faktorer og brugen af byens grønne områder. Talrige individuelle faktorer som alder, udannelse og det at have små børn, hænger sammen med brugen af grønne områder. Dette bliver endnu tydeligere når respondenterne er delt i fem segmenter, der hver især har deres egne karakteristika og et anderledes brugsmønster. Afstand, størrelse, antal af elementer og antallet af oplevelser, er de fire miljø faktorer der ser ud til at påvirke brugen af de grønne områder. Reduktionsparametre for hver af de fire faktorer er brugt til at opbygge en model for attraktiviteten af byens grønne områder. Modellen er tilpasset for hver enkelt af de fem segmenter.

I modsætning til mange andre studier, ser det ikke ud til at afstand er en begrænsende factor for flertallet af Danskerne, og mange respondenter i Odense har angivet, at de er villig til at gå forbi deres nærmeste område, for at besøge deres mest brugte område. Dette indikerer, at en generel strategi for at bringe grønne områder tættere på mennesker, måske har begrænset effekt i Danmark. Derfor vil jeg anbefale, brugen af lokalt tilpassede strategier der ved en grundig analyse af både beboer såvel som de eksisterende grønne arealer i lokalområdet finder de begrænsende faktorer. I dette ph.d. projekt er der udviklet nogle redskaber der kan hjælpe til at lave denne analyse.

SAMENVATTING

Dit proefschrift gaat over het gebruik van stedelijk groen en het begrijpen van de verschillende faktoren die dit beinvloeden. De belangrijkste hypothese is dat de meeste groene gebieden meer gebruikt zouden kunnen worden als groenbeheerders de juiste keuzes maken in het plannen en managen van stedelijk groen. Om de juiste keuzes te kunnen maken is het belangrijk te begrijpen welke faktoren het gebruik van stedelijk groen beinvloeden, en veel van deze kennis is momenteel niet aanwezig. Het gebruik van stedelijk groen is onderzocht aan de hand van gegeven van een nationaal onderzoek in Denemarken (n=11 238), en een lokaal onderzoek in de Deense stad Odense (n = 1 305). In Odense is ook gedetailerde informatie over het stedelijk groen verzameld. Logistieke regressie analyses zijn gebruikt om de samenhang tussen mogelijke voorspellende faktoren en het gebruik van stedelijk groen, en fysieke aktiviteit, te onderzoeken. Een Latent Class Analysis is uitgevoerd om klusters te ontdekken, en decay parameters zijn gebruikt om de aantrekkelijkheid van stedelijk groen te modelleren.

De resultaten laten zien dat zowel individuele als milieu faktoren samenhangen met het gebruik van stedelijk groen. Individuele faktoren zoals leeftijd, opleiding, en het hebben van kleine kinderen hangen samen met het gebruik van stedelijk groen en dit wordt nog duidelijker als de respondenten in vijf klusters worden ingedeelt die uitgesproken eigenschappen en een bestemt gebruikspatroon hebben. Afstand, grote, het aantal kenmerken, en het aantal belevingen zijn de vier milieu faktoren die effekt op gebruik lijken te hebben, en de decay faktoren voor deze vier parameters zijn gebruikt om de aantrekkelijkheid van stedelijk groen te modelleren. Het model is aangepast for de vijf klusters.

In tegenstelling tot de resultaten van veel andere studies lijkt afstand geen beperkende faktor te zijn van de meerderheid van de Denen, en respondenten in Odense gaven aan de ze voorbij het dichtstbijzijnde stedelijk groen gaan naar het meest bezochte stedelijke groen. Dit wijst erop dat een algemene aanbeveling om meer stedelijk groen dichtbij mensen te aan te leggen waarschijnlijk niet veel resultaat zal hebben in Denemarken en daarom raad ik aan gebruik te maken van een strategie die aangepast is aan de plaatselijke situatie op basis van een goede analyse van de buurt en de bewoners. Binnen dit projekt zijn metodes ontwikkeld die hierbij kunnen helpen.

PREFACE

This PhD project has been in the making for quite some time. It officially started in May 2005, but the first ideas and funding applications were already drawn up in 2003. In the period before starting, my supervisor Thomas Randrup and I explored several funding possibilities and with each application, the idea was developed further. Eventually, we managed to secure the needed funding from the Danish Outdoor Council, the City of Odense, and the University of Copenhagen.

In fall 2005, I got the opportunity to cooperate with Jens Troelsen, University of Southern Denmark, Institute of Sports Science and Clinical Biomechanics, on a questionnaire survey in the City of Odense. The empirical data collected in this survey has been essential to my PhD project.

During the course of the project, I was so fortunate to visit two institutions abroad. In 2006, I spent two weeks at the USDA Forest Service, in Syracuse, working at their Urban Forests, Environmental Quality and Human Health unit. And in 2007, I was a guest researcher at Alterra in Wageningen, the Netherlands, for three months. Both periods have been very useful; in particular I learned that it was not possible to describe the characteristics that influence use of a specific green space from a map or aerial photographs; something that I initially assumed.

The six months during which I had my main work space at the green space management office in the City of Odense was another very useful period. This period made me realise how green space management works in practice, and gave me a good insight into what type of information is needed for management decisions.

Another period that brought many new inputs to this project was the close cooperation with colleagues at the National Institute for Public Health during 2008. Three questions on green space had been included in the national health survey and analysing this data and writing three papers together (one is included in this thesis) greatly increased my understanding for the health benefits associated with the use of green space. I also learned a lot about doing logistic regression analyses, a statistical method I ended up using extensively.

In November 2008, Thomas Randrup left the university, and I needed a new main supervisor. After working with Thomas for several years and learning a lot about green space management, I felt that a different perspective on things could be refreshing. I was therefore very pleased that Ulrika Stigsdotter was willing to take over the role of main supervisor. Her extensive experience with environmental psychology and the health benefits of green space has been of great added value to the project in its final phase.

After four and a half years the project has come to an end and I feel that I have learned a lot about the use of urban green space and especially about doing research. I am looking forward to apply my new knowledge and competences in the future.

Jasper Schipperijn

Copenhagen, November 2009

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1. INTRODUCTION

This PhD thesis deals with the use of urban green space and understanding the various factors that (can) influence this use. The use of urban green space, and especially increasing the use, has become a hot topic for many green space managers the past few years as the assumed link between use of urban green space and health and well-being is becoming visible on political agendas. Many recent national and local health policies, as well as city planning policies, are mentioning the positive effects of the use of green space (e.g. Aarestrup et al., 2007; Harrison et al., 1995; Public Health Office Copenhagen, 2006; Stanners & Bourdeau, 1995). Some of these policies include clear aims for increasing or improving the use of green space, as primary means of utilising the health benefits from green space (e.g. Public Health Office Copenhagen, 2006).

1.1 Cooperation with public health researchers

Somewhat to my surprise, I realised during the first year of working on this PhD project that the increased focus on the health benefits of urban green space also means that the majority of recent research on the use of urban green space is carried out within the field of public health and not within the fields of green space management or city planning (e.g. Bedimo-Rung et al., 2005; Giles-Corti et al., 2005a; Hillsdon et al., 2006). Much research is carried out under the flag of 'active living'; a global movement aiming to stimulate the general activity level of people to help increase their health (for more information see www.activeliving.org). Cooperation between the different fields is strongly recommended by the initiators of active living (Sallis et al., 2006). However, I found that cross references between the different fields are still relatively rare and it seems that sometimes the 'wheel is invented twice' with different fields coming up with similar tools or methods, fully independent from each other. The development of detailed description systems to record the characteristics of green space is one clear example of this, with methods being developed by both fields simultaneously (e.g. Bedimo-Rung et al., 2006; Giles-Corti & Donovan, 2003; Hillsdon et al., 2006; Saelens et al., 2006; Troped et al., 2006; Tyrväinen et al., 2007; Van Herzele & Wiedemann, 2003).

In this PhD thesis I have actively tried to address the use of urban green space from multiple sides, including methods and approaches from the field of green space management as well as the field of public health. During the course of this project I have cooperated intensively with researchers from the National Institute of Public Health as well as the Institute of Sports Science and Clinical Biomechanics; both part of the University of Southern Denmark.

My view on how to do research in this field is to a large extent driven by the desire to generate knowledge that can help solve problems experienced in practice by green space managers and city planners, for the benefit of local green space users. This view has lead me to use a rather pragmatic and functionalistic approach in this PhD thesis. I suppose my methodological approach could be seen as a form of constructivism in which I assume that form follows function and in which I allow myself to simplify and structure 'reality' into models that make 'reality' easier to work with.

1.2 Hypothesis and research questions

My main hypothesis is that most green spaces have the potential to be used more and that this dormant potential can be utilised if green space managers make the 'right' choices in the planning and management of urban green space. However logic this might sound, it is easier said than done. It is often unclear what city planners and green space managers can and should do to increase or improve the use of green space. From a research perspective there is a lack of knowledge and understanding of the different factors that influence the use of green space, and their relative importance for different types of users. From a management and planning perspective more specific information is lacking about which green space features could be changed or improved at a specific site to improve use of that site. It is furthermore unclear which facilities and experiences are provided by the existing supply of urban green space, which facilities and experiences are demanded by residents, and whether or not demand and supply are balanced.

To deal with this lack of knowledge and understanding, I am addressing the following five main research questions in this PhD project.

1. Which factors influence the use of green space in Denmark? (Paper I)
2. Which factors influence the use of urban green space in the central part of a larger city in Denmark? (Paper II)
3. What is the association between urban green space and physical activity in the central part of a larger city in Denmark? (Paper III)
4. Which types of users exist, and how can their use and preferences for urban green space be described? (Paper IV)
5. How attractive is the available urban green space for the average user as well as for different user groups? (Paper V)

Each question is addressed in a scientific paper, that together form the basis of this PhD thesis. Paper I: Factors influencing the use of green space: results from a Danish national representative survey is focusing on providing a general overview of the different factors that are associated with the use of green space based on data from a national survey. Paper II: Influences on the use of urban green space – a case study in Odense, Denmark has a similar focus but includes substantially more detail as it uses data from a local survey. Paper III: Beyond distance: association of physical activity and urban green space deals with a specific type of use, physical activity, and the characteristics of urban green space that are related to this. Paper IV: Typical users of urban green space – a latent class model deals with the demand side of urban green space and establishes what the different user groups want from their urban green space and how the use of urban green space differs for each group. Finally Paper V: Assessing the attractiveness of urban green space builds on the results from the first four papers and describes a method to assess the attractiveness of individual urban green spaces.

Before presenting the papers, this thesis starts with a background and conceptual framework prior to explaining the methods and data used. I then continue with an overview of the main results, a discussion of the results and methods, and finally I present a number of conclusions and recommendations for green space planning and management in practice, as well as recommendations for future research.

1.3 Definitions

A few terms and concepts are used frequently throughout this thesis and it is important to be familiar with how I defined these concepts in the context of this study when reading this thesis.

Urban green space (UGS) is defined as all publicly owned and publicly accessible open space with a high degree of cover by vegetation, e.g. parks, woodlands, nature areas and other green space. It can have a designed or cultural character as well as a more natural character. Only areas that can be entered by users are included.

Use of urban green space (use of UGS) is defined broadly as any sort of visit to an urban green space, without looking at the duration of the stay, the reason for visiting or the activity done while visiting; e.g. passing through on the way to a destination is also counted as use.

Physical activity (PA) is defined as the self-reported participation in organised or unorganised sport or exercise, both indoor and outdoors, at least once a week.

Health is defined by the World Health Organisation (1948) as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

Green space managers and city planners are defined broadly as all professionals within a public administration that work with the planning and managing of green space.

2. BACKGROUND

2.1 Research on the benefits of urban green space

In the past decade, the attention for urban green space (UGS) and especially the benefits related to it has grown, as has the volume of research dealing with these benefits. Health benefits are much in focus at the moment, but UGS provides many other benefits. Creating a better understanding of the use of UGS is the main aim of this thesis and for that reason I feel that the conceptual model of green space benefits developed by Bedimo-Rung et al. (2005), which includes human behaviour as a central factor, provides the best basis for understanding how I see the benefits of UGS. In figure 1 I have adapted the original model by replacing the word ‘park’ with ‘UGS’ because this thesis deals with all types of UGS, not only parks . The lower section of the model shows the factors that influence the use of UGS and these factors can roughly be divided into the characteristics of the user (individual factors such as age, gender, education, preferences) and the characteristics of the UGS (environmental factors such as size, features, type, distance to). The middle section of the model illustrates the extent and nature of the use of UGS. All types of visits to an UGS are included here. Once users are in an UGS they can be more or less physically active during their visit. The top section of the model represents the various outcomes (or benefits) resulting from UGS and use of UGS. Psychological and physical health benefits, as well as social benefits are thought to be related to use of UGS. Economic or ecological benefits are also likely to accumulate from the mere presence of green space in a city.

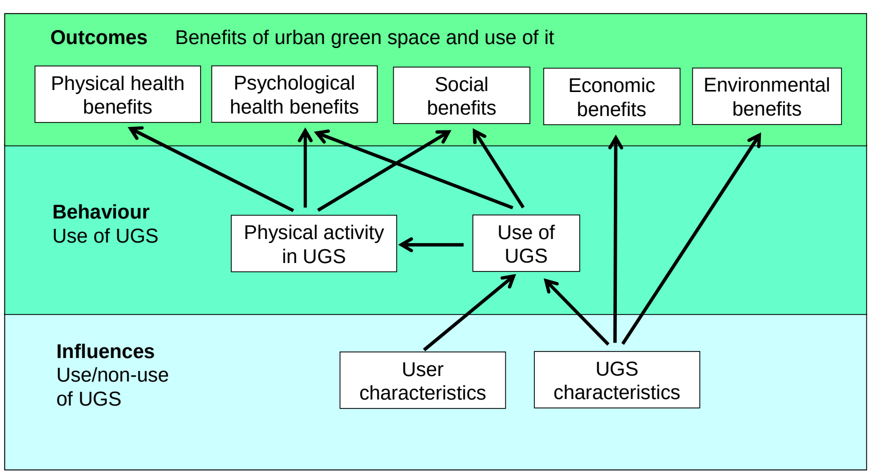


Figure 1. A model for the benefits of urban green space. Adapted from Bedimo-Rung et al. (2005)

2.1.1 Physical health benefits

Increasing the general level of physical activity (PA) is an important health strategy as two thirds of the adult population does not reach the levels of PA recommended by the World Health Organisation (Edwards & Tsouros, 2006). The role parks and other green spaces can play in providing a location for PA is receiving more and more focus and there is little doubt that use of UGS, and especially a more active use, provides direct physical health benefits to the users (e.g. Pretty et al., 2007). Some studies even indicate that the health improving effects of PA in green space are larger than the effects of indoor PA with a similar intensity (Hug et al., 2009; Pretty et al., 2005), most likely due to the larger psychological restoration effect of PA in green space. However, it is not clear what it is exactly that stimulates people to become physical active in UGS. Positive associations with increased levels of PA are reported for the amount of UGS close to home (Kaczynski et al., 2009; Li et al., 2005), the distance to the nearest UGS (Foster et al., 2004; Giles-Corti et al., 2005a), the size of the nearest UGS (Giles-Corti et al., 2005a; Kaczynski et al., 2008) and the presence of certain features (Kaczynski et al., 2008). But, a review by Kaczynski and Henderson (2007) demonstrated that the evidence is somewhat inconclusive and a wide range of measures and methods has been used, making it difficult to compare the results directly. According to Kaczynski et al. (2009), this methodological variation is common for most research on UGS and PA, and this type of research has furthermore been limited by a lack of detail in describing the characteristics of UGS and a lack of detail in measuring PA, causing poor theoretical correspondence, and therefore mixed results.

2.1.2 Psychological health benefits

Green space is providing psychological health benefits by restoring mental fatigue (Kaplan, 2001), reducing stress levels (e.g., Grahn & Stigsdotter, 2003; Hartig et al., 2003; Nielsen & Hansen, 2007; Ulrich, 2006), improving one’s mood, and enhancing one’s sense of wellness (Grahn & Stigsdotter, 2003; Kaplan et al. 1998). It is often assumed that the ability of green space to help improve or restore psychological health can be explained by one or both of two theories. The Attention Restoration Theory (ART) suggests that natural environments can help people restore from the information overload they typically receive in urban environments as nature contains very little information that must be sorted and assessed. ART implies that more natural environments are chosen rationally and intentionally when people are looking for a place to relax (Kaplan & Kaplan, 1989). The Aesthetic Affective Theory (AAT) proposes that the human affection for nature is related to its evolution as a species that was part of its natural environment. This means that humans have inherited the capacity to recognise safe natural environments where they can relax from their ancestors that lived in close harmony with nature. AAT suggests that people's preference for more natural environments as place for mental restoration is an intuitive choice and not a rational one (Ulrich, 1983).

2.1.3 Social benefits

Green space can provide places where people can meet and develop social ties (Coley et al., 1997; Kuo et al., 1998, Sullivan et al., 2004). A study by Sullivan et al. (2004) in Chicago found that the presence of trees and grass is related to the use of outdoor spaces, the amount of social activity that takes place within them, and the proportion of social to nonsocial activities they support. Coley et al. (1997, p487) found that 'the presence of trees consistently predicted greater use of outdoor spaces by all people, young and older, as well as groupings of people consisting of both youth and adults together'. Kuo et al. (1998) found that levels of vegetation are positively associated with both the use of common spaces and the strength of neighbourhood social ties. Maas et al. (2009a) found that after adjustment for socio-economic and demographic characteristics, less green space in people's living environment coincided with feelings of loneliness and with perceived shortage of social support. Maas et al., (2009b) also studied the effect of green space on the feeling of social safety and their analyses suggest that more green space in people's living environment is associated with enhanced feelings of social safety, except in strongly urban areas, where enclosed green spaces are associated with reduced feelings of social safety. Besides offering meeting places, green space can also promote a sense of community (Kim & Kaplan, 2004) by increasing feelings of emotional attachment to a neighbourhood (Prezza et al., 2001). Urban green space can also play an important role in providing a suitable setting for outdoor education and outdoor learning (Bell et al., 2007; Bentsen et al., 2009).

2.1.4 Environmental benefits

UGS provides many direct environmental benefits. Urban trees for example help improve the air quality by capturing air pollution (Nowak et al., 2006), by absorbing pollution in their cells and retaining pollution on their (leaf) surface. However, even though urban trees remove tons of air pollutants (O_3, PM_{10}, NO_2, SO_2, CO_2) annually, the average air quality improvement in US cities during the daytime of the vegetation in-leaf season were typically less than one percent (Nowak et al., 2006). Urban vegetation also contributes to the reduction of atmospheric CO_2 by direct sequestration (McPherson, 1998; Nowak & Crane, 2002), and when placed strategically, by reducing energy consumption for heating and cooling (Simpson, 1998). Urban green space helps to reduce the urban heath island effect. A study measuring air temperature at 10 sites on a transect across Primrose Hill, a London park, found temperatures to be on average 0.6ºC cooler in the park than on neighbouring streets over a 12 hour period. The main shopping street, which offered no shading, was up to 3ºC warmer than the centre of the park (Graves et al., 2001). Urban green space can also help to improve urban hydrology by intercepting rainfall (Xiao et al., 2000), increasing rainwater infiltration and increasing the water storage capacity (Tyrväinen et al., 2005). Also the presence of UGS, and especially urban woodland, can reduce surface runoff (Pauleit & Duhme, 2000).

2.1.5 Economic benefits

All mentioned benefits of UGS can in one way or other be calculated economically, e.g. avoided cost for establishment of more rainwater retention basins or reduced energy consumption, but also reduced healthcare costs due to a reduction in air-pollution or an increase in physical activity. Making this type of calculations is relatively common in the USA, and extensive models to calculate the total economic value of UGS have been developed. A prominent set of tools in this respect are the iTreetools (for more information see www.itreetools.org) that include a range of scientific models developed in the USA to calculate the benefits of street trees and/or the total urban forest ecosystem. It furthermore includes a model aimed specifically at calculating hydrological benefits.

Increased property values for homes overlooking or close to UGS are a documented example of direct economic benefits from various countries and for several types of green space (e.g. Anthon et al., 2005; Kong et al., 2006; Morancho, 2003; Powe et al., 1997; Tyrväinen & Miettinen, 2000). House prices are 4.9% higher with a forest view in Finland (Tyrvainen & Miettinen, 2000) and 8% higher with a park view in The Netherlands (Luttik, 2000). Morancho (2003) reports a 1% reduction in sales prices for each 100m further away from an UGS in Spain. This knowledge is not new; it was for example already used by Frederic Law Olmsted when arguing for the benefits of Central Park, New York, in the 1860s (Olmsted & Kimball, 1970).

2.1.6 Negative sides of UGS

UGS does not only deliver benefits to society and increasing the use of UGS is not always positive. UGS are seen as dangerous places (Jorgensen et al., 2007; Ward Thompson et al., 2004) and people might fear going there (Jorgensen & Anthopoulou, 2007; Van den Berg & Ter Heijne, 2005). Furthermore, an increasing number of people has to deal with pollen allergies and urban vegetation is an important source of allergenic pollen in cities (Mothes et al., 2004; Ribeiro et al., 2009). Increasing the use of UGS is not always positive either, crowding effects can occur (Arnberger & Haider, 2005; Price & Chambers, 2000), as well as conflicts between different user groups (Arnberger, 2006), and wear and tear of the vegetation might become a problem (Kissling et al., 2009; Lehvävirta et al., 2004).

2.2 Research on the use of urban green space

2.2.1 THREE TYPES OF STUDIES ON THE USE OF URBAN GREEN SPACE

Looking at studies on the use of UGS published in the past 10 years, it becomes clear that in most studies data were collected on-site by means of surveys or observations using selected UGS as case studies (e.g. Arnberger, 2006; Arnberger & Eder, 2007; Chiesura, 2004; Gobster, 2002; Guldager & Jensen, 2005; Janowsky & Becker, 2003; Randrup et al., 2008; Roovers et al., 2002; Tinsley et al., 2002; Yilmaz et al., 2007). This type of studies provides a good picture of the people actually using an UGS and their preferences, but it does not include the views of potential users that are currently not using the UGS. A few studies have a setup that provides data on both current users and potential users by randomly selecting residents that live in the vicinity of a selected green space and including them in a postal or telephone survey (Coles & Bussey, 2000; Payne et al., 2002; Randrup et al., 2008). This second type of studies has the advantage that it can reveal possible barriers or constraints for not using a certain UGS. However, both types of studies focus on the use of one specific area for each respondent and information of the use of other UGS that are also in the vicinity is typically not collected. A third group of studies looked at the use of all UGS close to respondents' home in one or more cities or neighbourhoods by conducting a postal or telephone survey targeting randomly selected citizens (Giles-Corti et al., 2005a; Grahn & Stigsdotter, 2003; Hillsdon et al., 2006; Holm, 2000; Kaczynski et al., 2009; Neuvonen et al., 2007; Sanesi & Chiarello, 2006; Sasidharan et al., 2005; Tyrväinen et al., 2007). This type of studies provides good information on the total use of UGS, as respondents tend to use more than one area, but most of these studies lack knowledge on exactly which UGS is used for what.

The results from the different studies show both similarities and differences in use of UGS for the various study sites. The frequency of use varies from at least one visit per week for 26% of the respondents in Bari, Italy (Sanesi & Chiarello, 2006), to around 50% in Denmark (Nielsen & Hansen, 2006) and in four cities in the USA (Sasidharan et al., 2005), to 95% visiting at least once a week in Eastern Helsinki, Finland (Tyrväinen et al, 2007). Going for a walk is by far the most common activity (Arnberger & Eder 2007; Neuvonen et al., 2007; Nielsen & Hansen, 2006) and to relax and be in nature are the most common motivations for visiting UGS (Chiesura, 2004; Nielsen & Hansen, 2006). In Denmark lack of time and bad weather are mentioned most frequently as main constraints for not using UGS more frequent (Nielsen & Hansen, 2006), whereas distance is not seen as problematic by most respondents (Nielsen & Hansen, 2006).

2.2.2 Factors influencing the use of urban green space

According to the found literature, distance to green space is the most important factor related to its use. The closer a green space is to each individual home, the more it is used (Björk et al., 2008; Coles & Bussey, 2000; Giles-Corti et al., 2005a; Grahn & Stigsdotter, 2003; Jensen & Koch, 2004; Nielsen & Hansen, 2007; Roovers et al., 2002). A distance of 300-400 metres is often mentioned as threshold after which use start to decline (Coles & Bussey, 2000; Giles-Corti et al., 2005a; Grahn & Stigsdotter, 2003; Nielsen & Hansen, 2007). None the less, I have only found a few studies that actually looked at the distance city residents have to travel to their nearest green space (Barbosa et al., 2007; Comber et al., 2008; Kessel et al. 2009; Oh & Jeong, 2007; Van Herzele & Wiedemann, 2003). The results of these five studies, all based on data from one or more cities, show that the majority of the population in these cities does not have access to green space within 300 metres, however, at least 90% of the population does have access to green space within 900-1000 metres.

Several studies report significant differences in the use of green space for different population segments (Coles & Bussey, 2000; Galloway, 2002; Holm, 2000; Payne et al., 2002; Sasidharan et al., 2005; Sanesi & Chiarello, 2006; Tinsley et al., 2002; Yilmaz et al., 2007). Finally, some studies report different characteristics of green space, such as size and the presence of facilities, to have an effect on its use (Coles & Bussey, 2000; Giles-Corti et al., 2005a; Kaczynski et al., 2009).

When looking at the available literature, it is unclear whether or not the availability of UGS is equally distributed among the different socio-economic classes in society. Some North American studies (e.g. Heynen et al., 2006; Wolch et al., 2005) conclude that deprived areas have less green space whereas Barbosa et al. (2007) and Kessel et al. (2009) found that areas with a lower socio-economic status have better access to green space in two UK cities, and the same was found in Perth, Australia, by Giles-Corti and Donovan (2002).

2.2.3 Policies and guidelines including the use of urban green space

The importance of providing green space close to where people live is recognised in various city planning and health policies (e.g. Harrison et al., 1995; Public Health Office Copenhagen, 2006, Stanners & Bourdeau, 1995). The European Environmental Agency (EEA) recommends that people should have access to green space within 15 minutes walking distance (Stanners & Bourdeau, 1995). In the UK, Natural England recommends that everyone should have access to a green space of at least two hectares within 300 metres of their home (Harrison et al., 1995). Denmark does not have any national norms or recommendations on this field, but some cities use their own standards, e.g. the city of Copenhagen has recently adopted a new planning strategy that includes an aim of providing green space within 400 metres for at least 90% of its population in 2015 (Public Health Office Copenhagen, 2006). In the Government Platform of 2007, the Danish Government included green space as one of the focus areas where city planning could promote an active lifestyle (Government Platform, 2007).

2.2.4 Research priorities

Bell et al. (2007) mapped research priorities for green space in the UK and mentioned the lack of baseline data on people's use of parks and other green space as first crosscutting theme that needs to be addressed by future research. They state that this is the kind of basic research upon which much else can be founded. It includes who does and does not use green space, categorised by social group, age group, gender, ethnic group and patterns of use over time and in relation to age/life stage.

A study by James et al. (2009) aimed at creating an integrated understanding of green space in the European built environment, suggested a range of research questions that need addressing; among other: 1) what are personal and social influences that result in greater use of urban green spaces; and 2) what are the necessary quantities, qualities and configuration of urban green space that contribute to their regular use such that different segments of a society with changing socio-demographic characteristics may gain benefits.

Based on the research on the use of UGS that I have found, it seems that there have been done many detailed studies of the use of one specific UGS, but most studies that look at the use of more than one UGS lack detailed information on which UGS is used for what, and how often. All UGSs in a city or neighbourhood are different, as are the residents living around them. And since the available studies show that the characteristics of an UGS can influence its use, knowledge on which UGS is used by whom, for what, and how that relates to the characteristics of each UGS, will be a useful addition to the research in this field.

3. THEORETICAL BACKGROUND: UNDERSTANDING THE USE OF URBAN GREEN SPACE

3.1 A socio-ecological model

A theoretical approach that I find useful when looking at the use of UGS is the so-called socio-ecological model. Within the field of leisure research (e.g. Raymore, 2002), physical activity research (e.g. Owen et al., 2004), and active living research (e.g. Sallis et al., 2006), this model is widely used as a conceptual framework to structure and understand factors influencing human behaviour. Studying the use of UGS could be part of all three above mentioned scientific fields, and for that reason, I have chosen to use a socio-ecological model as framework for understanding the use of UGS. The idea behind the socio-ecological model is that the environment humans live in should be seen and studied in the same way as the environment for plants and animals, which basically comes down to the idea that you cannot understand a person's behaviour without understanding the 'system' or 'environment' he or she lives in (Bronfenbrenner, 1979). In a socio-ecological model, various levels of influence on a person's behaviour are distinguished that, according to Giles-Corti (2006), can be divided into individual factors (e.g. age, education, personal experiences, friends, family) and environmental factors (e.g. physical environment, cultural environment, policy environment).

As recommended by Giles-Corti et al. (2005b), I constructed a specific socio-ecological model as framework for understanding the use of UGS, see figure 2.

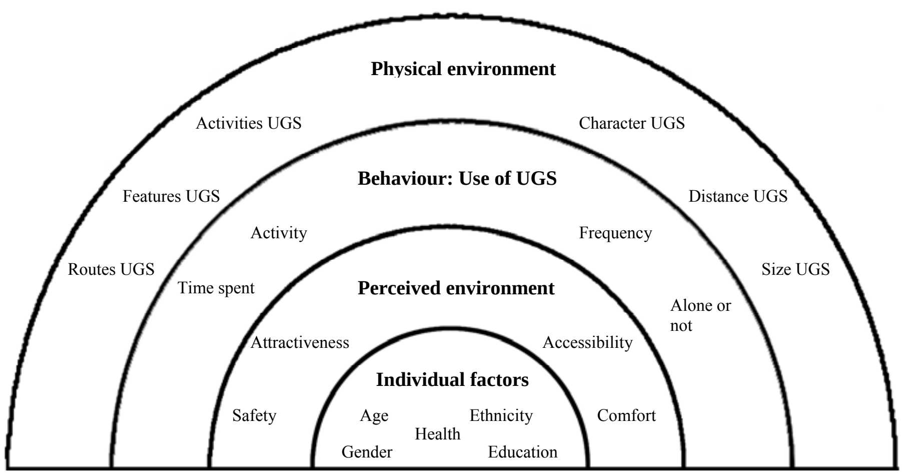


Figure 2. A socio-ecological model for the use of urban green space. Inspired by Giles-Corti et al. (2005b) and Sallis et al. (2006).

The model in figure 2 shows that the behaviour 'use of UGS' can be seen as the result of individual factors, the perceived environment, the physical environment and various interactions.

3.1.1 Individual factors

As mentioned in section 2.2.2, various studies have found correlations between individual factors such as age, education, gender and ethnicity and the use of UGS (Payne et al., 2002; Roovers et al., 2002; Giles-Corti et al., 2005a; Galloway, 2002; Gobster, 2002; De Vries & De Bruin 1998). Furthermore, according to Neuvonen et al. (2007) participating in outdoor recreational activities is influenced by the social environment; if a person's friends and family commonly participate in outdoor recreation, this person is more likely to participate too.

3.1.2 Physical environmental factors

Distance, size, presence of facilities and possibility for activities are all thought to affect the use of UGS (e.g. Coles & Busey, 2000; Kaczynski et al., 2008; Van Herzele & Wiedemann, 2003; Bedimo-Rung et al., 2005; Giles-Corti et al., 2005a). Distance is frequently reported as the main environmental factor influencing the use of green space (e.g. Coles & Busey 2000, Van Herzele & Wiedemann 2003, Giles-Corti et al. 2005a). However, the methods used to measure distance to, describe the characteristics, attractiveness or quality of UGS in more detail, vary considerably between the different studies and the results are therefore not directly comparable. Millington et al. (2009) distinguish three main types of environmental assessment; self-reported environmental perception by residents; standardised field assessment by experts; assessment of measurable environmental features using a Geographic Information System. The different methods each have their own benefits and drawbacks, and researchers therefore increasingly use multiple methods (Millington et al., 2009).

3.1.3 Perceived environmental factors

The discussion on whether subjective or objective environmental assessments are to be preferred is very much ongoing. McCormack et al. (2004) argue for more studies that combine various assessment methods to determine the respective association of subjective as well as objective environmental features. Lackey and Kaczynski (2009) report poor correspondence between objectively and subjectively assessed distances to the nearest park. Others (e.g. Scott et al., 2007) report that perceived environmental factors are a better predictor for behaviour than objectively measured environmental factors. Van den Berg (2007) explains the poor correspondence between objective and perceived environmental factors by dividing space into three separate, but closely related parts: inner space, experienced space and outer space, see figure 3.

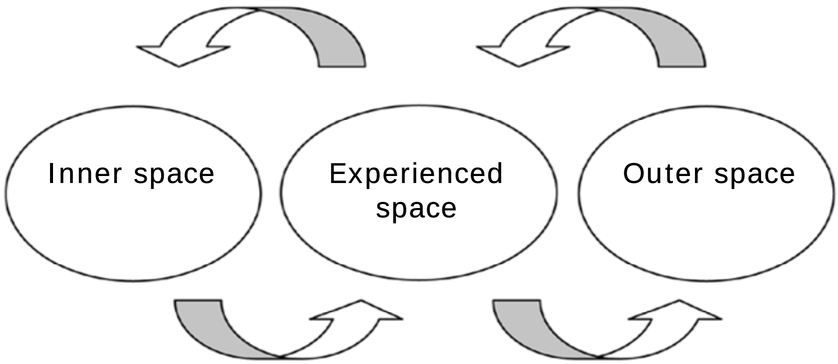


Figure 3. Inner, outer and experienced space. Translated from Van den Berg (2007).

Outer space is the ‘real’ space that can be described objectively. Inner space is the state of mind of each individual person, including his or her previous experiences, preferences, mood, etc. According to Van Den Berg (2007), inner and outer space are connected by means of experienced space, which could be described as the individual perception of ‘real’ outer space. Based on her review, Van Den Berg (2007) concludes that the way a space is experienced has more effect on behaviour than the objectively measurable characteristics of that space.

3.1.4 Combination of factors and interaction between factors

According to Giles-Corti (2006), few published studies have examined the relative influence of individual and physical environmental factors on physical activity. An Australian study done by Giles-Corti and Donovan (2002) shows that the direct influence of the physical environment on the level of physical activity was secondary to individual and social environmental factors. Based on the same material, they also looked at relative influence of the environmental versus the individual factors on walking and found them to be almost equally important (Giles-Corti & Donovan, 2003). Based on the finding that individual and environmental factors are almost equally important in stimulating walking, Giles-Corti (2006) argues for an intervention strategy that focuses both on people and places. She also suggests targeting future interventions to specific population groups since the relative importance of the different factors varies for each population segment.

4. PRACTICAL BACKGROUND: WHAT CAN CITY PLANNERS AND UGS MANAGERS DO?

4.1 Improving planning and management of UGS

Focusing on the relatively changeable environmental factors instead of the 'unchangeable' individual factors (Bedimo-Rung et al., 2005) seems logic from the perspective of city planners or green space managers; it is their job to plan and manage the physical environment. However, when making changes in the physical environment it is important to realise that each user of UGS has different preferences and needs. This makes it essential to understand the individual factors that influence the use and perception of a specific UGS before making any changes in how it looks or how it is managed. Environmental factors constraining the use for one person might stimulate use for another person and vice versa (Raymore, 2002). E.g. before renewing play equipment on a playground it is essential to know if its lack of use is due to the worn-down play equipment, or due to the fact that the children in the neighbourhood have become older and would like a whole different type of playground.

Furthermore, all factors influencing the use of green space can, and will, interact with each other and a solution that works in one situation might not work in another situation; each city has its own structure, each UGS its own characteristics and each neighbourhood its own inhabitants. To be able to deliver site specific solutions it is necessary to have a good overview of both supply and demand of UGS. A good neighbourhood analysis that reveals which factors are limiting the use of a specific UGS is essential if changes in the UGS are to have a positive effect on the use of it. Which UGS are where and what do they offer? And which inhabitants live where and what do they want? And most important, are there possibilities to improve the match between supply and demand?

4.2 Describing the supply of UGS

UGS managers have in the past decade developed various systems to describe the supply of UGS from a maintenance point of view (e.g. City of Odense, 2008; Juul et al., 1998). The characteristics of each UGS are recorded in great detail, often in a GIS. These descriptions are then linked with what needs to be done where, by whom and how often to reach the desired maintenance standard. These detailed descriptions are very suitable for their intended maintenance functions but the relation between maintenance standards, function, and use of a green space is not always clear.
Methods to describe the supply of UGS for use by city planners have been developed. E.g. Van Herzele and Wiedemann (2003) developed a method to

monitor the provision of accessible and attractive urban green spaces. Their method is based on a normative calculation of catchment areas for each green space primarily based on its size. The larger the green space, the longer people are willing to travel to it, the larger the catchment area. The size of the catchment area is adjusted for the quality of the area, based on an expert assessment of five quality attributes; space, nature, culture and history, quietness, and facilities. The lower a green space scores on each quality attribute, the more the catchment area is reduced. The use of this type of planning methods appears to be less widespread than the use of maintenance related tools for the description of UGS.

Within the field of public health research, the need to describe UGS in more detail also became evident and this has lead to the recent development of various tools to assess UGS characteristics, attractiveness or quality. The focus of each of these tools is slightly different, but most of these tools seem to be based on systematic recordings made by trained observes, often combined with other data in a GIS (for a review see Moudon & Lee, 2003). Only a few tools have been systematically tested and were found reliable, e.g. the Systematic Pedestrian and Cycling Environmental Scan (SPACES) developed by Pikora et al. (2002), the Bedimo-Rung Assessment Tool (BRAT) by Bedimo-Rung et al. (2006), and the Environmental Assessment of Public Recreation Spaces (EAPRS) instrument by Saelens et al. (2006).

4.2.1 Using subjective experiences in green space planning

The reported relation of subjective experiences with behaviour is difficult to work with in a planning context. How does he or she analyse which experiences are found where, and how important these experiences are to visitors? Berggren-Bärring and Grahn (1995) recognised this problem and constructed eight so-called park characteristics based on a survey on UGS preferences in Sweden among organised users. These eight park characteristics each describe a subjective experience and some crucial physical characteristics of the space it appears in. The original park characteristics were not developed with a direct practical application in mind, but various methods and tools have been inspired by them since (e.g. Björk et al., 2008; Caspersen & Olafsson, 2006; 2009). In a resent study, Grahn & Stigsdotter (in press) redefined the eight park characteristics into eight so-called sensory perceived dimensions of UGS based on the use and preferences for UGS of 953 individual respondents. In a study by Randrup et al. (2008), a method was developed based on these renewed park characteristics and this method focused on the more subjective, abstract, evaluation of experiences that are present in an UGS which makes this method more suitable for analysis of single parks or other UGS.

4.3 Describing the demand for UGS

Whereas spatial description systems for the supply of UGS are relatively common, the situation looks different for systems that can describe the demand for UGS spatially. As mentioned in section 3.1.1, there are significant differences in the use of UGS depending on the individual characteristics of the users (e.g. Galloway, 2002; Gobster, 2002; De Vries & De Bruin, 1998). In theory the demand for UGS in a certain neighbourhood could be estimated using population demographics, e.g. a neighbourhood with a lot of families with small children will require a different type of UGS than a neighbourhood with mainly elderly people. However, as also the level of education and personal preferences play a role in determining the demand for UGS (Payne et al., 2002; Roovers et al., 2002; Giles-Corti et al., 2005a), more detailed information about the neighbourhood residents is needed to estimate demand accurately. This information will often be available in municipal statistics departments, but it does not seem to be used very much by green space managers, perhaps because they seldom have direct access to it, or possibly because it is not available in GIS, reducing the possibilities to combine it with the other data on UGS.

In theory matching the local supply of UGS with the local demand should result in optimised use of UGS, which in turn should help to increase health and well-being of the urban population. However, a good supply and demand analysis is currently difficult to make as the information needed, as well as the tools needed to collect this information, are not available.

4.4 Organisational context

This thesis does not focus on the organisational structure of green space planning and management, but to be able to understand how city planners and green space managers work with UGS, it is important to be aware of the organisational context they work in.

Most green space management departments in Denmark, and many other countries, have undergone large organisational changes in the past two or three decades in the framework of New Public Management (NPM). The main idea of NPM is that public organisations become more like companies and become more focused on outputs and customer service. A second NPM idea is that the role of public organisations should become smaller and that more tasks should be taken over by private companies (Hood, 1991). These changes have often resulted in separation of green space maintenance from green space management. A Nordic study by Randrup and Persson (2009) showed that a green space management organisation typically is responsible for the descriptions of the maintenance tasks, and controlling the results. The actual maintenance tasks might be outsourced to private contractors, or they are purchased from an in-house maintenance provider. Green space management organisations are often part of a larger technical or leisure department in the municipalities, up to two organisational levels removed from the political system. Maintenance is clearly the most important task for the average municipal green space management organisation in Nordic countries, and they spend the majority (70-85%) of their resources (time and money) on maintenance tasks. Many cities have experienced budget cuts in the past five years (Randrup & Person, 2009).

Budgets for green space management are determined by municipal politicians, and the strong maintenance focus seems to have lead to a relatively low interest from politicians in UGS. For that reason, it is important for green space managers to highlight which benefits to society green space can contribute to. One way of doing this is by strategic cooperation with other departments, e.g. the health or education department. This way of thinking is relatively new in many cities, but looks promising. However, tools to support this type of strategic green space management are not readily available and existing UGS data has a strong maintenance focus and is often less suitable to support the making of strategic decisions.

5. METHODS

To be able to answer the five main research questions, I used data on the use of green space from a large national representative survey in Denmark (n = 11 238), carried out by the Danish National Institute of Public Health, University of Southern Denmark. The data from this survey was used to provide a general overview of the use of green space in Denmark. In a second, local study, we collected more detailed data on the use of UGS using a postal survey in the City of Odense (n = 1 305). In the same study area, detailed information on the available green spaces was also compiled. In the local study the aim was to collect data with a high level of detail, which makes it possible to study the effect of many factors simultaneously and, according to Flyvbjerg (2001) it will be possible to draw parallels to other cases based on this due to the high level of detail and in-depth understanding.

Denmark is a good location for surveys that involve geographic locations as each Dane has a unique personal registration number that is linked to their address. This means for example that respondents can be randomly sampled within a specified geographic area, and that background data can be drawn from Statistics Denmark.

5.1 National survey

The Danish National Institute of Public Health, University of Southern Denmark has carried out national representative interview surveys since 1987; see Ekholm et al. (2009) for a detailed description of the survey and its methodology. Three questions on the use of green space were included in the 2005 edition of this survey and the respondents were asked about the distance from their home to different types of green space as well as the frequency of use of each type of green space. Moreover, all respondents were asked about their main reasons for visiting green space. The survey was based on a regionally-stratified random sample of 21 832 adult Danes and 11 238 persons (52%) returned the questionnaire part of the survey that included the three green space questions. The survey had its main focus on health, and most questions dealt with different health aspects, e.g. exercising, eating, drinking, smoking and experiencing stress. Respondents were also asked for more general demographic information such as age, gender, number of children and level of education. The associations between the use of UGS and a range of individual as well as environmental factors were tested using logistic regression analyses. The analyses were done using SAS version 9.1.

5.2 Local study

The City of Odense was selected for the local study because of its image of being a green city and the availability of detailed information on all UGS; it was chosen as a critical case (Flyvbjerg, 2004). The aim with selecting a critical case is to be able to make logical deductions of the type ‘if this is (not) valid for this case, then it applies to all (no) cases’ (Flyvbjerg, 2004, p426). The local study was carried out in the central part of Odense and as there was no logic boundary for the study area, we chose to draw a circle with a two kilometre radius with the main railway station as central point as border of the case study area (see figure 4). Many different types of data were collected in the study area.

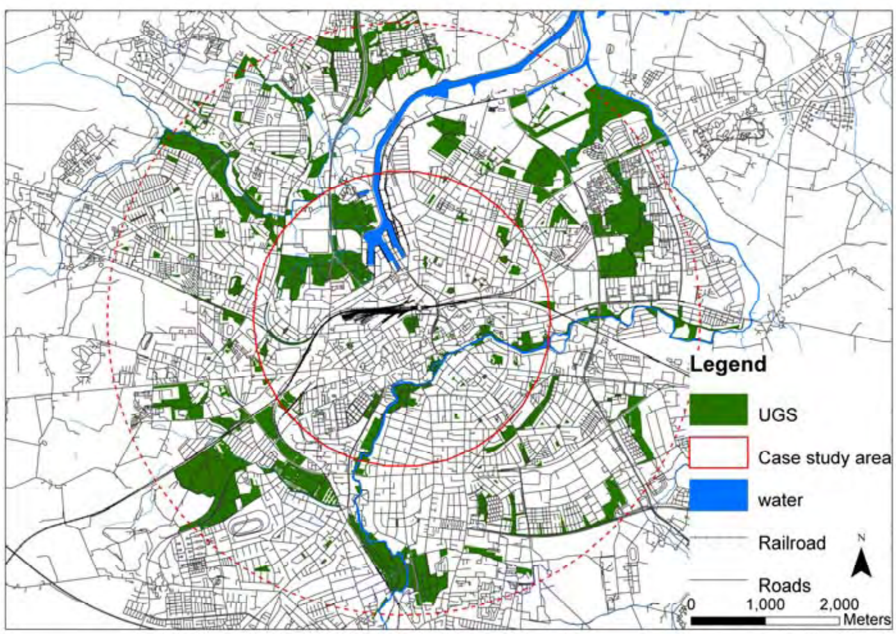


Figure 4. UGS in the study area in Odense.

5.2.1 Local Survey

A postal questionnaire was sent to 2 500 residents aged 18-80, randomly selected by Municipal Statistics Department in Odense, and 1 305 persons (52.2%) returned the questionnaire. The respondents were asked about the distance from their home to the nearest UGS as well as 10 selected UGS, and about the frequency of use of each of these 10 UGS as well as their nearest UGS. A series of questions dealt with preferences for facilities and experiences as well as possible constraints for use. Another set of questions was addressing various health aspects of the respondents. Finally, respondents were also asked for more general demographic information such as age, gender, number of children and level of education.

5.2.2 Municipal GIS data on UGS

The information available in the GIS-based green space management information system used by the City of Odense was used as basic UGS information. The system contains detailed information on all publicly owned and managed UGS; their exact location, size and different elements in the area. Data on UGS were extracted for the study area in the City of Odense (see figure 4), as well as a two kilometre buffer surrounding the study area. Only UGS that had at least one entrance and could actually be visited were included, which meant that e.g. roadside plantings with no trails going trough them, or sports fields without full public access were excluded. All UGS entrances, derived from the municipal UGS data, and verified during field visits, were added as a separate GIS layer. The study area is a relatively green area with a total of 53 UGS, but most UGS are small. Only two of these areas are more than ten hectares in size (both relatively remote woodland areas), four are between five and 10 hectares (all central), 15 are between one and five hectares and the remaining 32 UGS are less than one hectare. Including all UGS within the buffer area, data on 160 UGS with a total of 870 entrances were part of the study.

5.2.3 Features of UGS

As mentioned in section 4.2, various tools have been developed to describe the features of UGS. The features included in these tools are relatively similar to each other and I have chosen to use the Environmental Assessment of Public Recreation Spaces (EAPRS) instrument developed by Saelens et al. (2006) as this tool was tested and found reliable in various settings (Saelens et al., 2006; Kaczynski et al. 2008). However, similar to Kaczynski et al. (2008), I did not include the quality assessments included in the EAPRS tool as these were reported to be less reliable (Saelens et al., 2006). In all UGS in study area, as well as those UGS located just outside the study area, the presence or absence of 39 features based on the main categories used in the EAPRS was assessed. The presence of lights along at least one trail was added as a separate category and became feature number 40 as this was found to be an important feature in a study by Giles-Corti et al. (2005). A full list of all features can be found in Paper III.

5.2.4 Experiences in UGS

As mentioned in sections 3.1.3 and 4.2.1, the objectively measurable characteristics of UGS might be less important for users than the subjective experiences present in an UGS. For that reason, I also collected data on the experiences present in all UGS in study area, as well as those UGS located just outside the study area. The method I used to collect the experience values builds on a study by Grahn and Stigsdotter (in press), and was further developed by Randrup et al. (2008) in a project closely related to this PhD project. The method consists of two steps; firstly rooms are identified within each UGS, and secondly within each room the presence of eight different experiences is recorded. If an experience is present, it is classified as either weak (1), medium (2) or strong (3). The eight experiences are described in figure 5. For each UGS an experience score was calculated by multiplying the number of different experiences present with their respective strength; e.g. an area with three experiences that are respectively medium, medium and strong has an experience score of seven.

5.2.5 Combining all data in a GIS

All different types of data collected in the study in the City of Odense have a spatial component and could therefore be compiled in a GIS (ArcGIS 9.3). The addresses of all respondents were added as anonymised address points in a separate GIS layer and all questionnaire data was then linked to each address point. In a similar way, all data on UGS were linked to all entrance points of each UGS. Having all data in a GIS provides the possibility of combining questionnaire data with UGS data in one analysis, which is a strength of the study design according to Millington et al. (2009).

5.2.6 Calculating the distance to the nearest UGS

Two measures for the distance from the address of each respondent to each UGS entrance were calculated: Euclidian distance (‘as the crow flies’) and network distance. The Euclidian distance was analysed using a so-called ‘Near analysis’ in ArcGIS. The ArcGIS Network Analyst was used to calculate the network distance using a network dataset with all roads and trails accessible for pedestrians and cyclists available from The National Survey and Cadastre Agency of Denmark. Network distances have been shown to be a more precise measure for UGS proximity than using Euclidian distances (Oh & Jeong, 2007; Lee & Moudon, 2008), but are also more complicated to calculate, and not all GIS software packages can perform this task. Calculating both distances means that it is possible to compare the results for both types of distance and determine the relative improvement of calculating network distances instead of Euclidian distances. These results could furthermore be compared to the self-estimated distance to the nearest UGS we asked the respondents to determine in our survey.

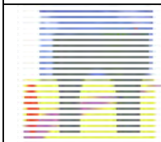
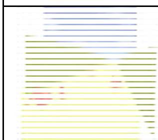
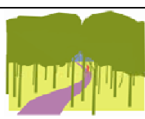
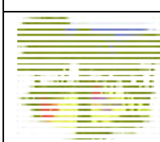
Illustration	Experienced quality	Describing sentence	Key-words
	Wild	The experience of a wild, free growing, untouched room that is difficult to access and where nature seems to be in control	-few other visitors -no signs or sounds of urbanity -nature's premises -wild
	Cultural-historic	A decorated (fountains, statues, water features, ornamental plants) room offering the experience of fascination for a lost time.	-cultural-historic relics recognisable for all -no need for other people, entertainments or activities
	Prospect	The experience of a large, open and robust room with long views and offers possibilities for many different sorts of activities.	- vistas - large and accessible - suitable for activities that demand lots of space -distinct walls
	Festive	A room offering the experience of amusement, services and other people.	- lots of people - service: restrooms, kiosks - good lighting - entertainment - many facilities and furniture
	Space	A room offering the experience of entering a different world, that is enclosed, but at the same time offers views of the surroundings	- enclosed, but with views of the surroundings - connected, but separate
	Rich in Species	A room offering the experience of life in form of a vast variety of both animals and plants (flora and fauna)	-natural plant – and animal populations - several animals both mammals, birds and insects -several plants
	Refuge	An enclosed room offering the experience of safety and shelter, where you feel safe, play or watch other people being active	-robust -safe -both children's and adults territory -tables and benches -play equipment
	Serene	A silent and calm room that offers the experiences of retreat, safeness, being one with nature and being undisturbed	- visual and auditory peace - no disturbing people - no litter - well maintained

Figure 5. Eight experience values, based on Randrup et al., 2008. Illustrations by Berit I. Hansen.

5.2.7 Association between predicting factors and use of UGS

The associations between the use of UGS and a range of individual as well as environmental factors were tested using logistic regression analyses. For paper II and III, I analysed the data from the local survey using SPSS/PASW version 16 and 17 respectively. Logistic regression analysis was chosen as main method as it does not require the need to assume linearity of relationships between the independent variable and the dependent, or a normal distribution of the data (Hosmer & Lemeshow, 2000). Both these requirements are hard to justify for the type of data that was used in this project.

5.2.8 Creating a typology of users of UGS

To be able to create a typology of user of UGS in Paper IV, we conducted a Latent Class Analysis (LCA) using the specialised statistical software LatentGOLD (version 3.0). A LCA identifies related cases (latent classes) of respondents using combinations of observed and unobserved (latent) data. A typical LCA model includes both background factors and behavioural factors, e.g. type of activities done in UGS. The cases are classified into clusters based upon membership probabilities estimated directly from the model. Contrary to many other clustering methods, a LCA does not require a dependant variable and nominal, ordinal and continuous variables can be included in the same model. Similar to Logistic Regression, LCA does not require linear relationships, normal distribution or homogeneity (Magidson & Vermunt, 2004).

5.2.9 Assessing the attractiveness of UGS

According to Van Herzele and Wiedemann (2003), the attractiveness of an UGS for a user is influenced by a combination of different factors, primarily size and quality, and of course how far away the area is from a respondent's home. Also Giles-Corti et al. (2005) and Hillsdon et al. (2006) corrected their attractiveness models of UGS for size and quality of each area. However, the quality parameters used in these three studies differ considerably. In this project, I have assumed that the attractiveness is influenced by the distance to the area, the size of the area, and the quality of the area, which is expressed by the number of features present, and the number and strength of the experiences present. The data for these four factors for the 10 selected UGS were combined with the survey data on the use of the same 10 UGS, which made it possible to calculate decay parameters for the attractiveness of each of the 10 UGS. To estimate decay parameters for the distance between the origins (the respondents home) and the destination (the nearest entrance to each UGS) a regression model was used in SAS. This produced beta coefficients that represent the decay parameters. The calculated decay parameters were then used to model the attractiveness of the UGS in the study area.

6. SUMMARY OF RESULTS

This thesis started with five research questions that each have been addressed in a one of the five papers. In the following section I summarise the main results of each paper, more detailed results can be found in the papers.

6.1 Use of green space in Denmark

The results of Paper I show that 66.9% of the respondents estimate that they live within 300 metres of green space, which indicates that distance to green space is not a limiting factor for the majority of the Danish population. However, for those one thirds of the populations that live further than 300 metres from their nearest green space, a significant distance decay in use of all types of green space can be seen; the larger the distance, the lower the frequency of use. Respondents living in large municipalities, or having a shorter education, are less likely to live close to green space compared to respondents in smaller municipalities, or with a longer education. Green space is much used compared to other public facilities, 43.0% visit green space every day and 91.5% visit green space at least once a week. Only 0.9% never visit green space. For men, the odds of visiting green space at least a few days a week increased with increasing age until the age of 80 years, thereafter it decreased. However, for women, no systematic pattern was found. Individuals with a shorter education or with a non-western ethnic background were less likely to visit green space at least a few times a week than individuals with a longer education or with a Danish background. To enjoy the weather and get fresh air is the most important motivation for visiting green space for 87.2% of the respondents. Other important motivations to visit green space are: to reduce stress, relax (58.3%); to exercise, keep in shape (54.7%); to do something together with friends and family (51.3%).

6.2 Factors influencing the use of UGS

Paper II shows that 62.8% of the respondents in the central part of Odense estimate that they live within 300 metres of an UGS, compared to 66.9% of the respondents from the national survey. Using the objectively measured network distances, 68.9% live within 300 metres of their nearest UGS. The nearest UGS is visited at least once a week by 56.2% of the respondents, 9.6% of the respondents visit their nearest UGS every day, and only 0.8% never visit it. Distance decay is also visible in this data, but at the same time almost half (46.3%) of the respondents did not use their nearest green space the most. Whether or not respondent used their nearest green space most depends primarily on area size, distance to the area and factors that are likely to express a reduced mobility; old age, young children and poor health. If the nearest urban green space also is the most used green space, having a dog is the only factor that significantly increases the frequency of use.

6.3 UGS and PA

The results of Paper III show that 74.3% of the respondents report to be physically active at least once a week and 45.7% state to be physically active at least once a week in their nearest UGS. The results demonstrate that age, health and education have a significant relation with PA in general and health and education have a significant relation with PA in the nearest UGS. The odds ratio for being physically active at least once a week generally decline with increasing age, whereas they increase with increasing health and a longer education. For being physically active in the nearest UGS an increase in the odds ration can be seen for health and education. No association between PA in general and size of, distance to, and number of features in the nearest UGS was found. The amount and number of UGS within one kilometre revealed no association either. Distance to the nearest UGS does not display an association with PA in the nearest UGS, but each additional feature increases the odds of being physically active, as does increasing UGS size. For PA in the nearest UGS positive associations with size, walking/cycling routes, wooded areas, water features, lights, pleasant views, bike rack and parking lot were found.

6.4 Typology of users of UGS

The results of Paper IV show that users of UGS living in the central part of the City of Odense can be grouped into five clusters that each have their own characteristics and differ in both their frequency of use of UGS, as well as their activities. They furthermore have different preferences for which features and experiences should be present in an UGS. The distribution of the clusters over the different neighbourhoods in the study area shows differences compared to the average, indicating that it might be useful for green space managers to adjust the green spaces in the different neighbourhoods according the inhabitants wishes. Cluster one consists mainly of middle aged, well educated respondents that rarely have young children. The second cluster is made up by young and well educated respondents, often couples, but typically without children. The third cluster consists of even younger respondents most of whom are still studying. Cluster number four is the cluster with the highest average age and a relatively low level of education. The last and fifth cluster consists primarily of respondents with young children.

6.5 Attractiveness of UGS

Finally, the results of Paper V show that it is possible to model the attractiveness of UGS based on four UGS characteristics: distance from the respondent, size, the number of features and number of experiences. Separate decay parameters were calculated for the different characteristics, and it becomes clear that respondents indeed are willing to go a bit further to visit an UGS with more features and experiences, typically a larger UGS. However, also the attraction of a high quality UGS is reduced with distance and a very attractive UGS that is too far away will not attract regular visits despite its large attractiveness. The attractiveness model was also tested for the five clusters of typical users of UGS and this showed that young families in cluster five are most likely to travel further to an UGS that fulfils their demands, which might be explained by the importance of good playgrounds for respondents in this cluster. Using an advanced model for the attractiveness of UGS in city planning requires a high level of information to be available to planners, but it will also help them to predict were the demand and supply of UGS do not match well, and where changes would benefit many potential users of UGS.

7. DISCUSSION

I started this PhD thesis with the daring, but also commonly accepted, hypothesis that most green spaces have the potential to be used more, if green space managers make the 'right' choices in the planning and management of urban green space. From a policy and practice point of view, it would have been very useful if I had been able to test the hypothesis, prove it right, and recommend exactly which choices city planners and green space managers could and should make to increase the use of UGS. Assuming that it would be possible to learn how to be a scientist and to do al this within three years was not very realistic. I had originally planned to include a small intervention study in which an UGS in the City of Odense would have been changed based on my recommendations to test the hypothesis. However, after doing the initial analysis of the results of the local survey, and studying the literature, I quickly discovered that coming up with the 'right' recommendations for change was easier said than done. The available knowledge on which factors affect the use of UGS, and how they interact, was not as easy to transfer to a Danish situation as I initially assumed, in fact several findings seemed to contradict each other. At the start of the project I very much missed a good conceptual framework to base my further analysis and recommendations on. For that reason, I focused on finding a good conceptual framework to make analysing and understanding the factors that influence the use of UGS possible.

In the following section I will discuss the results of this project as well as the methods and data used. Recommendations to practice and suggestions for future research will be addressed in section 8.

7.1 The socio-ecological model as framework for the use of UGS

After working with the socio-ecological model, commonly used in many related fields, I feel that it also is a very useful conceptual framework for understanding the use of UGS. The various factors that were reported to influence the use of UGS by other studies can now be placed in a context, as can the results found during this project.

7.1.1 Individual factors influencing the use of UGS

Based on the socio-ecological model, a large effect of individual factors can be expected, and indeed gender, age, education, marital status and ethnic background all have a significant association with the use of green space (Paper I), which was also found in other studies (e.g. Payne et al., 2002; Roovers et al., 2002; Yilmaz et al., 2007). Having a good health and a longer education are positively associated with being physically active in the nearest UGS (Paper III). When combing a range of individual factors with different activities, five types of users could be distinguished (Paper IV), that each have specific preferences for the features of UGS, a particular pattern of activities, and a distinct frequency of use.

Whether or not the nearest UGS is also the most used UGS is associated with personal factors that are likely to limit mobility; having young children, and an old age or a poor health (Paper II). However, if the nearest UGS is the most used UGS, personal factors have little or no effect on the frequency of use. Only having a dog makes a significant difference (Paper II). The lack of association with personal factors for using the nearest UGS seems to contradict the results of earlier studies (e.g. Roovers et al., 2002) and might be explained by the interaction with (perceived) environmental factors.

7.1.2 PERCEIVED ENVIRONMENTAL FACTORS INFLUENCING THE USE OF UGS

Perceived environmental factors are the second type of factors that are expected to have an effect on the use of UGS, according to the socio-ecological model. Compared with Euclidian distance and network distance, self estimated perceived distance is a better predictor for the frequency of use of urban UGS than the objectively measured distance (Paper II), which confirms similar findings by Scott et al. (2007). However, Lackey and Kaczynski (2009) showed that the correlation between the objective and self-estimated distance to the nearest park is rather poor, especially for people that do not use that park regularly. According to Scott et al. (2007), this might be explained by the fact that the distance to well-known, well-liked and well-used parks often is underestimated, while less-known, less-liked, or less-used parks are typically though to be further away then they are in reality.

Also perceived experiences that can be found in an UGS appear to influence the attractiveness of an UGS (Paper V), but to the experience score (number of experiences times their strength) it has a slightly negative effect, which can probably be explained by the fact that the eight experiences are so different, and can have opposite effects.

7.1.3 ENVIRONMENTAL FACTORS INFLUENCING THE USE OF UGS

Looking at the socio-ecological model, the third group of factors that is likely to influence the use of UGS are environmental factors. The results of Paper I-III and V show associations between use of UGS and the distance to, size of and the number of features present in an UGS, corrected for the effect of individual factors. The association of distance is reported by many other studies (e.g. Coles & Bussey, 2000; Giles-Corti et al., 2005a; Grahn & Stigsdotter, 2003; Roovers et al., 2002) and also the effects of size (Giles-Corti et al., 2005a) and the number of features (Kaczynski et al., 2008) have been demonstrated before.

However, 66.9% of Danes state that they have less than 300 metres to their nearest green space (Paper I). Within the City of Odense, 62.8% of the respondents state that they live within 300 metres of an UGS, and objectively measured, 68.9% live within 300 metres of their nearest UGS (Paper II), indicating that distance is not a limiting factor for the majority of the Danish population. These findings are in line with results of a Danish study by Nielsen and Hansen (2006) where only 3% of respondents considered distance to be a constraint for use. Compared to results from two studies in UK cities, it seems that access to UGS is relatively good in Denmark, even in a larger city. Brabosa et al. (2007) found that 64% of the population in Sheffield lived more than 300m from their nearest green space (of any size) and Comber et al. (2008) found that 89.7% of the population in Leicester did not have access to a green space of at least two hectares within 300 metres. If size of the UGS is taken into account in Odense, the numbers change a bit; 58.9% does not have a UGS of at least one hectare within 300 metres, and 83.9% does not have a UGS of at least five hectares within 300 metres (Paper II).

Furthermore, 46.3% of the respondents in the City of Odense are willing to go further than their nearest UGS to visit their most used UGS. Size of the nearest UGS is an important factor influencing whether or not this UGS will be the most used UGS and the further away the nearest UGS is, the larger the odds it will be the most used UGS (Paper II). It appears that an UGS needs to be at least five hectare to attract visitors to go past a smaller UGS closer by, and that this ‘pull effect’ starts to decline if the UGS is more than 600 metres from the resident’s home (Paper II).

A large part of the weekly visits to the nearest UGS in Odense is used for PA, 45.7% state to be physically active at least once a week in their nearest UGS, compared to 56.2% that visit their nearest UGS at least once a week (Paper III). In contrast to general use of the nearest UGS, distance to the nearest UGS is not significantly associated with PA (Paper III), which contradicts the findings by Giles-Corti et al. (2005a). But on the other hand, also Kaczynski et al. (2008; 2009) did not find a relation between the distance to UGS and PA in their studies. The number of features present in an UGS is positively associated with PA, as is size of the UGS (Paper III). Studying the association of the different features in more detail, it becomes clear that for PA in the nearest UGS positive associations exist for walking/cycling routes, wooded areas, water features, lights, pleasant views, bike rack and parking lot (Paper III). This indicates that PA in an UGS might be stimulated by providing these features there.

7.2 Discussion of methodology

In this PhD project data from two surveys were used, as well as a range of different types of data on UGS in Odense. The combination of all different data is a strength of this PhD project, but all data and methods used also have their drawbacks. In the following section, I will discuss the strengths and weaknesses of the different data and methods.

7.2.1 National survey

The major strength of the national survey is that it is based on a large national representative sample, which seems to be rather unique for a study on the use of green space. A possible limitation of this study could be the relatively high non-response rate (48%), but the non-response analyses showed no significant differences, which means that this is not likely to have influenced the results. The lack of detail on the green spaces the respondents referred to when answering the questions could be seen as the second limitation of the survey. It is unclear if the respondents refer to a small or a large green space, or how this green space looks. And as the respondents were not presented for a definition of the different types of green space, it is not exactly known when respondents identified a green space as being a certain type; i.e. when is a park seen as a park, or a forest as a forest. However, the aim of this survey was to create a national overview, and the local study did include detailed information on all UGS, so for the total PhD project this limitation seems less relevant.

7.2.2 Local survey

The study area for the local survey was selected with the aim of being a critical case in order to be able to make logical deductions of the type ‘if this is (not) valid for this case, then it applies to all (no) cases’ (Flyvbjerg, 2004, p426), and this seems to have worked. Access to UGS was generally good and the results showed an association with the quality of an UGS in attracting users, and it also became clear that users often are willing to go further than their nearest UGS if a more attractive area is within reach (Paper II). I have no reason to assume that these conclusions are not also valid in cities were UGS is less accessible, but of course, the effect of quality is likely to be less clear as distance will play a larger role.

Being able to link all data from this survey directly to anonymised address point in a GIS is a major strength as it enables the use of both survey data and other GIS data in the same analysis as recommended by e.g. McCormack et al. (2004) and Millington et al. (2009). Also, the relatively large number of respondents in a small area can be seen as strength and this enabled the creation of clusters of users in Paper IV. However, the local survey has one important drawback; it only asked about the use of the nearest

UGS, and not UGS in general. Based on the importance of distance reported in earlier studies, we assumed that the nearest UGS would be the most used UGS for most respondents, hence many of our questions were related to use of the nearest UGS. However, this assumption proved to be wrong, and I now know that it would have been better to ask about the use of UGS in general. Or even better, ask respondents to identify all UGS they use on a map and get as much detail as possible on the use of these areas and reason for this. A second limitation of this survey is that it is not certain that the UGS that is objectively the nearest also is the one that respondents refer to when mentioning their nearest area. Many of the UGS in the study area are relatively small, and perhaps they were not always recognised as usable UGS, even though only UGS with least one entrance and the actual possibility to be visited were included in the analysis. I kept these limitations in mind when concluding and recommending based on the result from this survey.

Finally, also for this survey the non-response rate was relatively high (47.8%) and therefore non-response analyses were carried out. The differences between the sample and the respondents were not significant and are not likely to have had a large impact on the results (Paper II).

7.2.3 Presence of features in an UGS

The EAPRS instrument used to describe UGS features was tested and found reliable (Saelens et al., 2006; Kaczynski et al., 2008). However, the features are just present or not present, and there is no indication of how often a feature appears and since I chose not to include the quality parameters, there is no indication of e.g. the quality of a playground either. Furthermore, the number of features seems to be related to the size of an UGS (Paper III and V). Interestingly, there is a clear similarity between the features preferred by the respondents and the features that are significantly associated with PA (Paper III), which indicates that it might be useful to expand the features recorded in the field with presence of other preferred features currently not included in the EAPRS instrument. Furthermore, some features of the EAPRS instrument were not present in any of the UGS in the City of Odense. All in all, I find that the idea behind the EAPRS instrument is very useful, but a simplified version adapted for use in Denmark might be more appropriate if the instrument is to be used in practice.

7.2.4 Presence of experiences in an UGS

The method used to record the presence of different experiences was developed by Randrup et al. (2008) and builds on many years of research in this topic in Sweden, most recently by Grahn and Stigsdotter (in press). However, the method has not been fully tested, and its reliability and validity are not proven yet. We did compare results for the different researchers that have used the method, and found a reasonable good reliability when assessing the same areas. In this thesis I used the method to get an impression of the quality of an UGS, and I analysed about 60 different UGS. However, it is still a bit unclear to me how the experiences can be used from a planning perspective. The experience score (total number of experiences times strength) we used in Paper V does not seem to be a good indicator for quality. More work is needed to develop the method into a tool that is useable for planning and managing UGS.

7.2.5 Modelling the attractiveness of UGS

The different environmental factors associated with the use of UGS were combined into an attractiveness model. In this model decay parameters were calculated for the attractiveness of UGS. This seems to be quite unique as I have only found one other study that calculated decay parameters for individual urban green spaces (Giles-Corti et al., 2005a), corrected for attractiveness of each area. The same parameters have been used in a study by Hillsdon et al. (2006), but applying factors calculated in Australia in the UK is questionable as decay parameters are influenced by region and culture (Skov-Petersen, 2001). It is therefore important to calculate the parameters for each new setting and the decay parameters calculated in this project are valid for Odense, and possibly for other Danish cities.

8. CONCLUSION AND RECOMMENDATIONS

Using the socio-ecological model as conceptual framework has greatly increased my understanding for the use of UGS, and together with the knowledge and experiences I gained during this project, I now feel that I have a solid background for making the analyses needed before recommending city planners and green space managers how to make the ‘right’ choices. In the following sections I will conclude with my recommendations for both practice and future research.

8.1 Implications for city planners and green space managers

What can and should city planners and green space managers do to increase or improve the use of green space?

8.1.1 Step 1: Get to know the (potential) users

The first step is to get to know the (potential) users, and find out where they live. The use of UGS is strongly influenced by many individual factors, and these factors can not be changed by city planners or green space managers. This project has shown that the different groups of user have distinct preferences for the contents of UGS, they participate in different activities, in various frequencies, are willing to travel different distances to UGS, and visit at different times of the day, week or year. Providing the desired types of UGS within a reasonable distance of city residents is likely to increase their use of UGS. For that reason, knowing were the different types of users live, and knowing what they want from an UGS, is important information for city planners and green space managers. This information could e.g. be collected in a survey, or by means of focus group interviews, but combining the results from this project with basic population demographics, often available from Municipal Statistics Departments, can already provide much of the needed information. Dividing residents into logical clusters, as was done in this project, can be helpful, but it will also require more advanced analysis to be carried out. It is important to give all information on (potential) users a spatial location; i.e. not only the number of e.g. young families living in a neighbourhood is important, knowing were they live is crucial too.

8.1.2 Step 2: Get to know the available UGS

Getting to know the available UGS is the second steps of the analysis, and to many green space managers this step might sound superfluous as they already know their areas. This is of course true, but I think that it can be very useful to add an additional perspective to the existing data on UGS: the user perspective. The available data on UGS is typically very maintenance focused, with detailed information on how many square metres of each element there are, and how this should be maintained. However, a typical user does not care about how many square metres of flowerbed or lawn there are, they care about finding the experiences and possibilities for activities they are looking for. Users that find what they are looking for, within their maximum travel distance, are happy users, and they are more likely to come again. For a green space manager this means that he or she should try to find out which experiences and possibilities each UGS offers to the users. Within this project two ways of doing this have been used, recording which features are present, and recording which experiences are present. Both methods could be used by green space managers, but in principle any method that provides a reasonable impression of what is 'on offer' to a user in each UGS will do. Also with this type of information it is important to make sure that all data has a spatial location; what is provided where.

8.1.3 Step 3: Matching the available UGS with the (potential) users

Finally, the most important, but also most complicated step in the analysis process, step 3, deals with matching supply, the available UGS, with demand, the (potential) users. The results of this step will lead to a 'to do list' for city planners and green space managers with actions that are likely to increase the use of UGS. There are more or less comprehensive and technically complicated ways to perform step 3, but calculating the distance from each (potential) user to each green space is an important part of the analysis. This is easiest in a GIS, and network distances provide the most accurate information, but calculating network distances is an advanced GIS operation that can not be preformed in every GIS package. Euclidian or buffer distances are less precise, but can be calculated in all GIS packages. The ideal solution would be to calculate the distance from each resident to each UGS, and for each UGS the number of residents within a certain distance should be determined. The result of this basic distance analysis will probably provide many insights already; e.g. it will be clear which respondents have to go more than 300 metres to their nearest UGS, and it will be clear which UGS have a high number of potential visitors. However, this project has clearly demonstrated that distance is not the only important factor to look at, so other information about both users as well as UGS should be included in the analysis to paint a true picture. Including the size of an UGS is a good start as larger UGS attract people to go a further from home and are preferred by many users, e.g. the distance to the nearest UGS of at least five hectares could be calculated. But also specific information about the available features is relevant to include, e.g. for families with young children the presence of a playground is very important, preferably close by. Many more analyses could be done, in great detail, so finding a good balance between time spent analysing and additional information gained is important.

How do these analyses lead to a ‘to do list’ for city planners and green space managers? Especially for a distance or size problem, solutions are often difficult to find as adding new or extending existing UGS is not easy in most cities. However, this study has shown that distance in many cases is not a problem. If distance is a problem, a possible solution might lie in the fact that people experience distance differently, and the experienced distance seems to decrease with increasing knowledge and appreciation for an UGS. This means that an effort to decrease the experienced distance, e.g. by making the UGS more well-known, might increase the use of it. Content problems, i.e. an UGS does not offer the desired experiences, are in theory easier to deal with as the design and content of an UGS can be changed.

8.1.4 Step 4: Prioritising actions

The important task of prioritising actions starts after making all analyses and compiling a ‘to do list’. This step is typically a political one, and it is up to city planners and green space managers to come up with good arguments as to why certain actions are more likely to have positive results than others. As mentioned earlier, cooperation with other municipal departments might make arguing for a good case easier, and might help to ‘lift’ green space management to a more strategic level.

8.2 Implications for health policies and plans

Which implication do the results of this project have for health policies and plans? Perhaps the most important fact to keep in mind for health policy makers is that this project confirmed that the characteristics of the physical environment are only one of the many factors that affect behaviour. There is a large variation in the use of UGS for different people, and different population segments, and the factors influencing the use of UGS can change from person to person, and from location to location. As mentioned above, a more detailed analysis of each local situation is needed to reveal which factors are influencing the behaviour most, and which factors are most likely to be influenced. In some cases changes in the physical environment might be the best solution; in other cases a whole different intervention, e.g. a more traditional information campaign, might be more successful. And in most situations a combination of various measures will probably give the best result, which confirms that the cooperation between health professionals and city planning professionals, which already has been initiated in many cities, is essential in the future.

8.3 Future research

Within this PhD project I studied the association between a range of individual factors, a range of environmental factors and the use of UGS and the results confirmed the socio-ecological hypothesis that both types of factors can help to explain behaviour. I furthermore used the data to develop a typology of users of UGS and a model for attractiveness of UGS in Paper IV and V that hopefully can help city planner and green space manages in practice. However, after completing this project I am left with some unanswered questions and ideas for future research.

8.3.1 EXACT LOCATION OF ALL UGS THAT ARE USED BY RESPONDENTS

Even though the Odense survey already contained more detailed information on UGS than many earlier studies, there is still room for improvement in the survey methodology if we want to understand the factors influencing the use of UGS even better. Knowing the exact location of all UGS the respondents use would eliminate the current doubts about e.g. if the subjective nearest area is also the objective nearest area. If data on the use of each of these areas, frequency of visits, time spent per visit and activity done, can be collected, the picture becomes even more complete and e.g. the reasons for choosing between different areas could also be studied. Technically, I can see a few solutions for including these locations in a survey. A first solution might be including a detailed map of the study area, and respondents could mark areas. However, this would limit the size of the study area, or it would require large printed maps, which would be rather unpractical. A second more practical solution could be a digital map as part of an internet survey. Of course a face-to-face interview survey could also be used, with either a paper or a digital map. A third way of collecting this type of data could be feasible for a smaller group of respondents that each would receive a GPS unit that records their position, and each respondent should keep a log-book on the activities that are done at the different locations. If the GPS is combined or integrated with an accelerometer or heard rate monitor the level of PA could be recorded simultaneously, providing valuable additional information (see e.g. Fjørtoft et al., 2009).

8.3.2 INTERVENTION OR LONGITUDINAL STUDIES

The results of this project, as well as other projects, have generated a number of hypotheses as to what could stimulate people to use their UGS more, or for a certain type of activity. To test causal relations longitudinal or intervention studies are needed. For example, both the quality of an UGS, but also the knowledge that people have about an UGS, are though to affect the use of the UGS. Testing the hypotheses by means of an intervention study in which changes are made to an UGS, or an information campaign is launched, seems like a promising perspective for future research to test if causal relations really exist.

8.3.3 Use of UGS in other cities and by other user groups

The availability of UGS in the study area in Odense was generally speaking very high and a study area with more variation in availability of UGS can be recommended. Carrying out similar studies in other cities will also create the opportunity to validate the decay parameter and typology of users that were developed in this project. Studying the use of UGS for other user groups than in our current study, such as children or teenagers could be another obvious direction for future research.

8.3.4 Qualitative studies

This project has had a clear quantitative approach, which is understandable as the project aimed at identifying a broad range of factors that could influence the use of UGS, both individual factors and environmental factors. However, the results of the project show a significant association for a number of individual factors, and indicate an association for perceived environmental factors. Exploring the importance of both these types of factors in more detail is an obvious direction for future research, and such an exploration is probably done best using qualitative methods, e.g. by means of focus group interviews.

8.3.5 A new socio-ecological model: four types of behaviour in UGS

Based on knowledge and experiences I gained during this project, I now hypothesise that certain features can be matched with certain experiences, and together they can be combined with certain types of activities, that in turn are demanded in varying degrees by different types of users. In short, I think that instead of using one universal socio-ecological model for the use of UGS (see figure 2 in section 3.1), a model with four separate behaviour sections would do more justice to reality and I have therefore created figure 6.

I propose four types of behaviour in UGS to be distinguished: active transport; active, mobile recreational activities; active, stationary, recreational activities; and passive, stationary recreational activities, see figure 6. I assume that different combinations of UGS characteristics are likely to influence each of the four types of behaviour, and I furthermore think that the likelihood that a person participates in one of the four types of activities also depends on who they are, which can be simplified to which cluster of users they belong to.

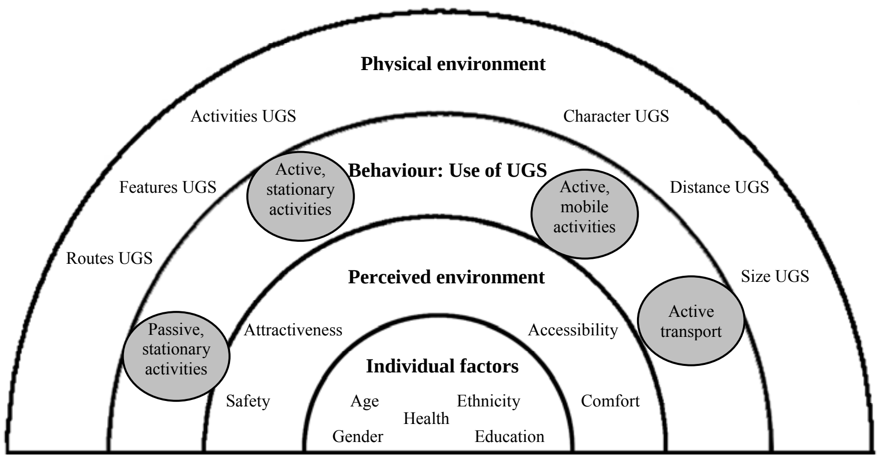


Figure 6. A socio-ecological model for the use of urban green space. Inspired by Giles-Corti et al. (2005b) and Sallis et al. (2006).

Active transport, especially cycling, in an UGS is likely to be stimulated by having good paved trails or routes with lights that appear safe and sheltered from the elements. Nice views and a peaceful experience will also contribute positively. From an active living perspective there is not much societal benefit to gain from moving cyclists from other routes into UGS, but any additional cyclist that stops using his or her car, is a clear benefit. Furthermore, a more green route might have a positive psychological effect. Bicycle use for most people in cluster three (students) and cluster two (young couples) is already very high, so they are not likely to increase there active transport. However, persons in cluster one (middle aged, well educated) and cluster five (family with young children) can probably be persuaded to exchange their car for their bicycle for some trips, if attractive, safe routes through UGS are provided.

Active, mobile recreational activities in an UGS are in a way similar to transport behaviour, but transport activities have to be done, whereas recreational activities are optional. For recreational walking, running and cycling this means that the quality of the UGS is more important, and the experience of being in nature and getting away from the city is essential. Good trails or routes, preferably paved with gravel, lights for evening and winter use, woodlands, water features, are all features that are likely to contribute, as are peaceful and wild experiences. Going for a walk in UGS is by far the most common activity and almost all people do this to a certain extent, and especially persons in cluster one and four (senior, low educated) like to go for a walk frequently, either alone or in small (family) groups, with or without their dog, and suitable UGS should therefore ideally be close to home. Running is an activity mainly done by younger people, especially belonging to cluster two, and cycling is popular especially among people in cluster one and two.

Active, stationary recreational activities are less common for most people and they require different qualities from an UGS. To be able to play soccer, or other team sports, there needs to be enough open space with good lawns. The UGS should feel safe and comfortable for longer stays. Travelling a bit further to reach a suitable site is no problem for most teenagers or adult users, but will be a problem for younger children. People in cluster three participate in these activities relatively frequent. A special group of active, stationary recreational activities are children's play activities, either on a specially designed playground, but just as often on other suitable sites. A good play site is safe, sheltered and enclosed, while at the same time offering enough (physical) challenges. The younger the children are, the closer to home the site should be and for parents to take the children for supervised play it helps if there are good facilities for the adults too. People in cluster five are, with their children, by far the most frequent users of UGS for play activities.

Finally, passive, stationary recreational activities are common for people in cluster three, and to a certain extent in cluster two, but these activities are characterised by a strong weather and time dependency. On a nice and sunny weekend day, or summer evening, demand for these activities will be high, but on most other times, demand is low. Typical activities in this category are reading, relaxing, sunbathing, eating and very important drinking. Travelling a bit further to find the right spot, with the right people, is no problem for most users. For many users these activities are first of all a social activity done together with friends, but on the other hand also many users like to do activities that fall into this category on their own, especially if they do not have their own garden. The ideal UGS for these activities should have many benches, a nice lawn, flowers and service facilities (café and/or toilet). The area can have serene, festive and historic experiences.

Future research will have to show if my hypothesis is realistic, and the four types of activities relevant.

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PAPER I

FACTORS INFLUENCING THE USE OF GREEN SPACE: RESULTS FROM A DANISH NATIONAL REPRESENTATIVE SURVEY

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Factors influencing the use of green space: Results from a Danish national representative survey

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ABSTRACT

Policy makers in Denmark are increasingly recognising the potential health benefits associated with green space, in particular with the use of green space. Knowledge on how green space is used, why it is used, and which factors influence its use, is becoming interesting for researchers, city planners and managers of green space. The present study is based on data from a nationwide study of 11 238 randomly selected adult Danes. Respondents were asked about the distance to four different types of green space, their frequency of use of each of these types of green space, and the main reasons for visiting green space. Multiple logistic regression analysis was used to investigate the association between potential predictor factors and visits to green space at least a few times per week. Results show that 66.9% of the respondents live within 300 m of green space, 43.0% visit green space every day and 91.5% visit green space at least once a week. Only 0.9% never visit green space. To enjoy the weather and get fresh air is the most important reason for visiting green space for 87.2% of the respondents. Distance to green space is not a limiting factor for the majority of the Danish population and for that reason we recommend a thorough analysis of a neighbourhood or city, its population, and the available green spaces, before deciding on a viable strategy to increase the use of green space.

1. Introduction

The importance of providing green space close to where people live is mentioned in various city planning and health policies (e.g. Stanners and Bourdeau, 1995; Harrison et al., 1995; Public Health Office Copenhagen, 2006; Aarestrup et al., 2007) as a short distance to green space is associated with increased use (Björk et al., 2008; Coles and Bussey, 2000; Giles-Corti et al., 2005; Grahn and Stigsdotter, 2003; Jensen and Koch, 2004; Nielsen and Hansen, 2007; Roovers et al., 2002). About 25% of the health policies in Denmark mention the importance of increasing the use of green space, primarily because they expect that this will have a positive effect on the health and well being of a large part of the population (Aarestrup et al., 2007).

1.1. Research on the use of green space

Studies on use of green space published in the past 10 years can be divided in three main groups. The first group of studies focuses on the use of one specific green space (e.g. Arnberger, 2006; Arnberger and Eder, 2007; Chiesura, 2004; Janowsky and Becker, 2003; Gobster, 2002; Payne et al., 2002; Roovers et al., 2002; Tinsley et al., 2002; Yilmaz et al., 2007). A second group of studies is focusing on regional or national samples of a particular type of green space, e.g. forests or national parks (e.g. Coles and Bussey, 2000; Hörnsten and Fredman, 2000; Jensen and Koch, 2004; Pergamsa and Zaradicb, 2006). And a third group of studies deals with the use of all types of green space close to respondents' home in one or more cities or neighbourhoods (e.g. Giles-Corti et al., 2005; Grahn and Stigsdotter, 2003; Hillsdon et al., 2006; Kaczynski et al., 2009; Neuvonen et al., 2007; Sanesi and Chiarello, 2006; Sasidharan et al., 2005; Tyrväinen et al., 2007). Finally, we also found one study with a regional focus on the use of all types of green space (Björk et al., 2008), and one national study focusing on the use of all types of green space (Nielsen and Hansen, 2006, 2007).

Several studies report significant differences in the use of green space for different population segments (Coles and Bussey, 2000; Galloway, 2002; Payne et al., 2002; Sasidharan et al., 2005; Sanesi and Chiarello, 2006; Tinsley et al., 2002; Yilmaz et al., 2007). Some

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studies report different characteristics of green space, such as size and the presence of facilities, to have an effect on its use (Coles and Bussey, 2000; Giles-Corti et al., 2005; Kaczynski et al., 2009). But distance to green space is commonly seen as the most important factor related to its use; the closer a green space is to each individual home, the more it is used (Björk et al., 2008; Coles and Bussey, 2000; Giles-Corti et al., 2005; Grahn and Stigsdotter, 2003; Jensen and Koch, 2004; Nielsen and Hansen, 2007; Roovers et al., 2002). A distance of 300–400 m is often mentioned as threshold after which use starts to decline more rapidly (Coles and Bussey, 2000; Giles-Corti et al., 2005; Grahn and Stigsdotter, 2003; Nielsen and Hansen, 2007). In the UK, Natural England recommends that everyone should have access to a green space of at least 2 ha within 300 m of their home (Harrison et al., 1995). The European Environment Agency (EEA) recommends that people should have access to green space within 15 min walking distance, roughly 900–1000 m (Stanners and Bourdeau, 1995). Denmark does not have national norms or recommendations in this field. However, the city of Copenhagen has recently adopted a new planning strategy that includes an aim of providing green space within 400 m for at least 90% of its population by 2015 (Public Health Office Copenhagen, 2006).

The number of studies we found that actually mapped the distance people have to travel to their nearest green space is relatively small (Barbosa et al., 2007; Comber et al., 2008; Kessel et al., 2009; Oh and Jeong, 2007; Van Herzele and Wiedemann, 2003). The results of these studies, all based on data from one or more cities, show that the majority of the population in these cities does not have access to green space within 300 m; however, at least 90% of the population does have access to green space within 900–1000 m. The European Environment Agency (EEA) reports similar findings for access to green space within 15 min walk in their 1995 assessment of a range of European cities (Stanners and Bourdeau, 1995).

1.2. Research priorities

The research priorities for green space in the UK were mapped by Bell et al. (2007) and they mention the *lack of baseline data on people's use of parks and other green space* as a first crosscutting theme that needs to be addressed by future research. They state that this is the kind of basic research upon which much else can be founded. It includes who does and does not use green space, categorised by social groups, age group, ethnic group and by the patterns of use over time and in relation to age/life stage (Bell et al., 2007). Bell and his colleagues furthermore state that little research is available on the access to green space. Our review seems to confirm this statement and information on the distance Danes have to travel to various types of green space is not readily available, and information on the availability of different types of green space across the country and across different socio-economic groups is also lacking.

1.3. Study aim

The aims of the current study are to describe and analyse the distance to green space in Denmark and the frequency of use of green space among different population groups, as well as describing and analysing the main reasons for using green space. Factors influencing the use of green space are also analysed.

Our study supplements earlier studies and will provide policy makers in Denmark with data from a large nationwide study on the use of green space, making it possible to argue constructively for further development and planning of green space. Furthermore, having better baseline data will enable urban planners and managers of green space to undertake targeted action to stimulate the use of green space.

2. Methods

The Danish National Institute of Public Health, University of Southern Denmark, has carried out national representative interview surveys since 1987. The purpose of these surveys is to describe the status and trends in health and morbidity in the adult population (16 years or older) and in the factors that influence health status, including health behaviour and health habits, lifestyles, environmental and occupational health risks and health resources; see Ekholm et al. (2009) for a more elaborate description. The data used in the present study were collected in the health interview survey of 2005 and are based on a regionally stratified random sample of 21 832 adult Danes. The sample was drawn from the Danish Civil Registration System in which each Dane has a unique personal registration number. All selected persons received a letter of introduction that briefly described the purpose and content of the survey, emphasising that participation was voluntary. The survey was approved by the Danish Data Protection Agency and data were collected by face-to-face interviews at the respondents' home, and following the interview, all respondents were asked to complete a questionnaire. The questions regarding distance to and use of green space that form the basis for this study were posed in this questionnaire. In all, 14 566 individuals (66.7%) completed a personal interview and 11 238 persons (77.1% of those who completed the face-to-face interview) returned the questionnaire.

The respondents were asked about the distance from their home to green space. The possible answer categories were: *less than 300 m*; *300 m–1 km*; *1–5 km*; and *more than 5 km*. The question was repeated for each of the following types of green space: *beach, sea or lake; parks; forests*; and *other open nature areas*, and the question included *agricultural fields*, but these have been excluded in the data analysis due to difficulties in assessing if and how agricultural fields can be used for outdoor recreation. The respondents were furthermore asked about the frequency of use of green space (*daily, several times per week, weekly, monthly, seldom or never*). Moreover, all respondents were asked about their main reasons for visiting green space. The respondents could choose from the following options: *to enjoy the weather and get fresh air*; *following the seasons and observing flora and fauna*; *to reduce stress, to relax*; *to exercise and keep in shape*; *to do something together with family or friends*; *to be in a peaceful and quiet environment*; *to have a job working with animals, agriculture or forest*; *other reasons*; and finally *do not visit green space at all*. Respondents could give more than one reason, but for the *do not visit green space at all* option answers were only included if no other categories had been mentioned.

The education status was classified according to The International Standard Classification of Education (ISCED), which combines school and vocational education. The interviewer recorded the type of accommodation at the time of the face-to-face interview, and the sizes of the Danish municipalities were obtained from Statistics Denmark. Ethnic background was based on the self-reported country of birth and parents' country of birth and categorised according to Statistic Denmark's definition of western and non-western countries. Citizens with a Danish background were defined as those with at least one parent born in Denmark and individuals with a non-western background were defined as persons born in a non-western country by parents who are not born in Denmark or persons born in Denmark by parents born in a non-western country. Furthermore, the respondents were asked about, e.g. their cohabitation status and number of children.

2.1. Statistical analysis

Multiple logistic regression analysis was used to investigate the association between potential predictors (gender, age, cohab-

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Table 1
The distance between residence and different types of green space and frequency of visits to these areas. Percentage.

	Beach, sea, lake	Park, green space	Forest	Other open natural area	Total – all green space
Distance from residence					
<300 m	16.6	53.5	21.2	39.2	66.9
300 m–1 km	22.2	31.2	28.2	27.5	26.9
1–5 km	33.6	12.4	34.6	22.6	6.0
>5 km	27.6	2.9	16.0	10.7	0.2
Frequency of visits					
Daily	13.4	30.8	11.0	27.1	43.0
Several times a week	19.9	27.8	15.7	19.8	29.9
Weekly	28.3	23.1	22.6	20.8	18.6
Monthly	28.4	12.6	33.6	20.6	6.6
Seldom or never	10.1	5.8	17.1	11.8	2.0
Distance from residence for daily visitors					
<300 m	54.9	81.1	70.3	76.6	85.4
300 m–1 km	23.7	15.1	20.1	16.2	12.7
1–5 km	15.5	3.4	8.7	5.8	1.8
>5 km	5.9	0.5	0.9	1.5	0.1
Frequency of visits for respondents living within 300 m					
Daily	44.3	46.8	36.7	52.9	54.8
Several times a week	27.5	28.4	25.2	22.4	27.5
Weekly	17.7	15.9	20.1	14.8	12.8
Monthly	7.7	6.7	13.9	7.1	3.9
Seldom or never	2.8	2.2	4.0	2.8	1.0

itation status, ISCED, accommodation type, size of municipality, socio-economic position and ethnic background) and having less than 300 m to green space. Multiple logistic regression analysis was also used to examine the relationship between potential predictors and visits to green space at least a few times per week between April and October. Interaction terms were used to examine the relation between gender and each of the potential predictor variables in determining the outcome. The results are presented as odds ratios (OR) with 95% confidence intervals (CI). Goodness-of-fit of the models was assessed by the Hosmer–Lemeshow test (Hosmer and Lemeshow, 2000), and the tests indicated that the models fit the data adequately. All estimates presented in this study were weighted to take into account the complex sampling design of the survey. Statistical analyses were performed using SAS Version 9.1.

3. Results

3.1. Distance to green space and frequency of use

As can be seen in Table 1, 66.9% of the respondents live within 300 m of any type of green space, and 53.5% reside within 300 m of a park, which is the most common green space to have nearest to one's home. Only 15.3% have to travel more than 1 km to their nearest park. The average distances to water and beaches, as well as forests are considerably longer; e.g. 27.6% need to travel more than 5 km to reach the sea, a beach or a lake. The frequency of use for the different types of green space varies: 43.0% of the respondents visit green space every day, while only 2.0% visit it seldom or never. Forest is the type of green space with the lowest frequency of visits; only 11.0% visit it daily, while 17.1% stated that they visit it seldom or never. Of all daily users of parks, 81.1% live within 300 m, 70.3% of all daily forest users live within 300 m, 76.6% of the users of other open green space live within 300 m, and 54.9% of all daily users of the sea, lakes and beaches live within 300 m. This might indicate that the effect of distance is strongest for parks whereas it is less important for the use of the sea, lakes and beaches. Of those respondents living within 300 m of the different types of green space, forests seem to be less popular for daily visits than the other types of green space: 36.7% visit a forest daily, while between 44.3 and 52.9% visit other green space daily.

3.2. Relation between frequency of use and distance

The results clearly show a decay in use of all types of green space; the larger the distance, the lower the frequency of use. The distance decay has a similar pattern for all four types of green space with the percentage of daily users dropping between 28.8 and 36.9% when the nearest green space is more than 300 m from the home (from 36.7–52.9% down to 7.9–16.0% depending on the type of green space). If the nearest green space is located more than 1 km from home the percentage of daily users drops to between 2.8 and 8.5% of the respondents. An example of the distance decay on the frequency of use of parks can be seen in Fig. 1.

3.3. Relation between socio-demographic and socio-economic variables and distance to green space

After confirming that distance also in the Danish context and for the whole country is an important factor in explaining differences in the frequency of use of green space it becomes interesting to know more about the distribution of green space among the population. Are there certain population segments (e.g. elderly, or families with children) or certain socio-economic groups that live significantly further from green space than others? The results in Table 2 show the relationship between socio-demographic and socio-economic variables and having less than 300 m to green space. There were no statistically significant interaction terms

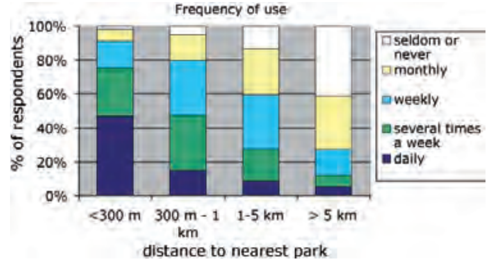

Fig. 1. Distance to the nearest park versus frequency of use, in percent of the respondents.

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Table 2
Result from multiple logistic regression analysis showing the association between different socio-demographic and socio-economic variables and having less than 300 m to green areas.

	Crude %	OR	95% CI	*N*
Gender				
Men	67.8	1.06	0.98–1.15	5158
Women	66.2	1		5934
Age				
16–24 years	68.6	1.26	1.04–1.53	959
25–44 years	66.0	1.01	0.91–1.12	3617
45–64 years	68.2	1		4304
65–79 years	65.4	0.93	0.82–1.06	1850
80+ years	65.0	1.03	0.81–1.31	362
*Combined school and vocational education**				
<10 years	65.0	0.82	0.72–0.93	1513
10–12 years	67.0	0.92	0.83–1.01	3010
≥13 years	67.1	1		6266
*Cohabitation status**				
Married	69.1	1		6505
Cohabiting	63.5	0.86	0.76–0.97	1665
Single (divorced, separated, widowed)	64.5	1.01	0.88–1.16	1308
Single (unmarried)	63.9	0.85	0.73–0.98	1610
*Accommodation type**				
Apartment building	56.5	0.74	0.66–0.82	2071
A single-, two-, three or four-family house, linked courtyard or townhouse	68.2	1		7830
Farm	87.0	2.77	2.22–3.45	923
Other (e.g. institution)	66.8	0.95	0.70–1.30	205
*Size of municipality**				
≥100 000 inhabitants	59.9	0.54	0.47–0.63	2205
40 000–<100 000 inhabitants	60.2	0.50	0.44–0.58	2224
20 000–<40 000 inhabitants	67.3	0.66	0.57–0.76	2042
10 000–<20 000 inhabitants	72.8	0.81	0.70–0.93	2529
<10 000 inhabitants	77.4	1		2092
Ethnic background				
Danish background	66.9	1		10 895
Other western background	68.8	1.21	0.79–1.86	100
Non-western background	69.0	1.69	1.03–2.78	94

* $p < 0.05$.

between gender and any of the potential predictor variables (all *p*-values > 0.05). The table shows that there is no association between age and having less than 300 m to green space ($p > 0.05$). However, the analysis indicated that younger respondents (aged 16–24) were more likely to have less than 300 m to green space than individuals in the age group 45–64 years (OR: 1.26; 95% CI: 1.04–1.53). The table furthermore shows that respondents living in large municipalities (>100 000 inhabitants) have lower odds of living less than 300 m from their nearest green space than individuals living in small municipalities (<10 000 inhabitants). Individuals with a shorter education (less than 10 years) had lower odds (OR: 0.82; 95% CI: 0.72–0.94) of reporting a short distance to green space than individuals with a longer education (13 years or more).

3.4. Factors influencing the use of green space

Considering that our earlier results (Table 1 and Fig. 1) indicate a clear distance decay effect it is not surprising that also the multiple logistic regression analysis reveals that the odds of using green space at least a few times a week (between April and October) were more than three times higher (OR: 3.26; 95% CI: 2.96–3.60) when respondents live within 300 m of their nearest green space compared with respondents living 300 m–1 km from green space (see Table 3). We furthermore found a statistically significant interaction term between gender and age. For men, the odds of visiting green space at least a few days a week increased with increasing age until the age of 80 years, thereafter it decreased. However, for women, no systematic pattern was found. Furthermore, the table shows that individuals with a shorter education were less likely to visit green space at least a few times a week than individuals with a longer education (OR: 0.81; 95% CI: 0.70–0.95). The table also shows that individuals with a non-western ethnic background had lower odds (OR: 0.38; 95% CI: 0.24–0.60) of visiting green space at least a few times a week than individuals with a Danish background.

3.5. Main reasons to visit green space

As can be seen in Table 4, *to enjoy the weather and get fresh air* is an important reason for visiting green space for 87.2% of the respondents. A difference in gender can be observed especially among young respondents: 77.8% of men and 91.8% of women between 16 and 24 years state this as an important reason. A similar gender difference can be seen for the second most important reason *to reduce stress, to relax*; 51.8% of men and 70.9% of women aged 16–24, respectively. *Stress reduction* as the main reason for a visit is clearly less important for people over 65 years, possibly indicating a general lower stress level after retirement. *Exercising and keeping in shape* is an important reason for 54.7% of the population, with little variation between gender and age groups. *Doing something together with family or friends* is equally popular among men and women, but loses importance with increasing age. Also, *to obtain peace and quiet* becomes less important with increasing age. Contrary to this, *following the seasons and observing flora and fauna* becomes more important with increasing age. Only 0.9% of the respondents never visit green space, with people over 80 being an exception (4.0 and 5.6% for men and women, respectively).

Table 3
Results from multiple logistic regression analysis showing the association between potential predictor variables and visits to green space at least a few days a week (between April and October).

	Crude %	OR	95% CI	*n*
Gender and age[*]				
Men				
16–24 years	64.5	0.43	0.32–0.58	397
25–44 years	66.3	0.52	0.44–0.60	1644
45–64 years	75.6	0.79	0.68–0.92	2019
65–79 years	77.7	1.03	0.84–1.26	920
80+ years	64.7	0.53	0.37–0.77	157
Women				
16–24 years	72.4	0.80	0.62–1.04	560
25–44 years	71.5	0.66	0.57–0.78	1965
45–64 years	78.1	1		2272
65–79 years	73.7	0.92	0.75–1.13	914
80+ years	54.9	0.40	0.28–0.55	198
Combined school and vocational education[*]				
<10 years	70.6	0.81	0.70–0.95	1503
10–12 years	71.7	0.85	0.76–0.95	2995
≥13 years	73.8	1		6245
Cohabitation status[*]				
Married	75.9	1		6474
Cohabiting	69.5	0.97	0.84–1.11	1656
Single (divorced, separated, widowed)	68.4	0.80	0.69–0.94	1308
Single (unmarried)	68.1	0.92	0.79–1.08	1604
Accommodation type[*]				
Apartment building	64.8	0.90	0.79–1.02	2061
A single-, two-, three or four-family house, linked courtyard or townhouse	73.9	1		7795
Farm	88.0	2.11	1.66–2.67	919
Other (e.g. institution)	69.9	0.96	0.69–1.34	206
Size of municipality				
≥100 000 inhabitants	67.0	1		2189
40 000–<100 000 inhabitants	69.6	1.03	0.90–1.18	2213
20 000–<40 000 inhabitants	74.1	1.15	0.99–1.34	2032
10 000–<20 000 inhabitants	76.6	1.15	0.99–1.34	2528
<10 000 inhabitants	78.8	1.22	1.03–1.44	2084
Distance to green space or natural areas[*]				
<300 m	82.3	3.26	2.96–3.60	7477
300 m–1 km	57.7	1		2831
>1 km	36.9	0.41	0.34–0.49	669
Ethnic background[*]				
Danish background	73.0	1		10 848
Other western background	73.0	1.00	0.62–1.59	101
Non-western background	53.5	0.38	0.24–0.60	94

[*] $p < 0.05$.

Table 4
The most important reasons for visiting green space by gender and age group. Percentage.

	Men						Women						Total
	16–24	25–44	45–64	65–79	80+	Total	16–24	25–44	45–64	65–79	80+	Total	
To enjoy the weather and get fresh air	77.8	83.1	83.9	85.7	77.9	83.3	91.8	92.5	91.0	87.4	77.9	90.6	87.2
To reduce stress, relax	51.8	63.9	55.8	31.0	25.9	52.8	70.9	72.9	65.9	39.0	22.9	63.1	58.3
To exercise, keep in shape	57.4	48.2	48.6	59.4	50.4	51.1	58.3	53.7	60.9	61.7	46.9	57.8	54.7
To do something together with friends and family	66.1	61.5	41.9	35.1	28.1	48.6	68.9	67.5	44.9	39.7	36.3	53.7	51.3
To follow the seasons, flora and fauna	12.4	33.4	48.7	55.1	58.0	42.3	22.4	40.0	57.6	58.7	46.8	48.1	45.4
To obtain peace and quiet without noise	33.4	32.3	30.3	23.4	24.6	29.8	44.3	32.6	32.6	23.0	14.5	31.6	30.8
Other reasons	21.5	23.2	27.0	26.6	25.0	25.2	17.0	20.3	22.5	21.4	15.9	20.8	22.9
Never visit green space	0.5	0.4	0.6	1.6	4.0	0.8	0.1	0.4	0.7	1.8	5.6	0.9	0.9
n	396	1645	2016	930	158	5145	560	1966	2278	924	205	5933	11 078

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4. Discussion

To our knowledge, this study is the first to examine factors influencing the use of green space based on such a large national representative sample. The results presented in this paper are part of a larger study investigating the relationship between health and green space and the possible health implications of our findings will be discussed in other publications.

4.1. Factors influencing the use of green space

Our results show that 66.9% of the population has access to a green space within 300 m; so for the majority of Danes distance is not likely to be a limiting factor for use of green space. This confirms earlier results of a Danish study by Nielsen and Hansen (2006) where only 3% of respondents considered distance to be a barrier for use. Accessibility to green space seems to be relatively good in Denmark, compared to results from two studies from the UK. Barbosa et al. (2007) found that 64% of the population in Sheffield lived more than 300 m from their nearest green space (of any size) and Comber et al. (2008) found that 89.7% of the population in Leicester did not have access to a green space of at least 2 ha within 300 m. We did not find studies from other countries that allowed a detailed comparison.

We did find a significant correlation between the use of green space and distance in our study, indicating that reducing the distance to green space for the remaining 33.1% of the population may increase their use of green space. Especially in the largest Danish municipalities (>100 000 inhabitants) this strategy seems valid as the odds of having less than 300 m to a green space are significantly lower (OR: 0.54; 95% CI: 0.47–0.63) compared to small municipalities (<10 000 inhabitants). The larger Danish cities seem to be aware of this already, e.g. in Copenhagen, the capital of Denmark, the *Health Policy 2006–2010* states that all citizens should have access to parks and other green space within 400 m of their home (Public Health Office Copenhagen, 2006).

For the majority of Danes, distance does not seem to limit the use of green space which makes it even more relevant to realise that gender, age, education, marital status and ethnic background all have a significant association with the use of green space. Similar differences were found in other studies (e.g. Payne et al., 2002; Roovers et al., 2002; Yilmaz et al., 2007). Different groups within the Danish society have different patterns of using green space and are likely to have varying constraints and facilitators for the use of green space, suggesting that there might be a need for multiple strategies, each focusing on a specific target group, to help increase the overall use of green space. Giles-Corti (2006) gives a similar recommendation based on results from a large study in Perth, Australia.

4.2. Use of green space compared to other cultural and recreational activities

Comparing the use of green space with other cultural, recreational and leisure activities that receive public funding in Denmark, it becomes clear that green space is very much used. Statistics Denmark has a comprehensive list of cultural activities with percentages of the population visiting or taking part in the activity at least once a year. Visits to a library are the most common cultural activity with approximately 64% of the population visiting at least one time a year (Bille et al., 2005), but only around 10% of the population visits a library at least weekly (Bille et al., 2005). Our study shows that nearly 82% of the Danish population visits a park at least once a week. Taking all types of green space together this increases to about 92%. However, many green spaces are used as a route for transport, and these 'passing through' visits are included. Visits to a park or a library are not in any way equal or substituting each other, but compared to the use of other cultural, recreational and leisure opportunities our study shows a high frequency of use of green space.

4.3. Future perspectives

Our results show a different use of green space, and various reasons for this use, for diverse groups of people. An interesting perspective for future research could be to explore these differences further and discover if it is possible to construct a number of typologies of users identifying their motivations, the activities they undertake in green space, as well as the facilitators and constraints that influence their use of green space. From a planning perspective this thought is especially interesting if these groups can be identified geographically, i.e. determine how many people of each typology live in a certain neighbourhood. Having this information would make it possible to design and manage green space according to what the expected local user wants.

We briefly explored the distribution of green space in relation to socio-economic variables in this paper, but a more detailed study seems relevant in the future as different authors come to different conclusions. Some North American studies (e.g. Heynen et al., 2006; Wolch et al., 2005) conclude that deprived areas have less green space whereas Barbosa et al. (2007) and Kessel et al. (2009) found that areas with a lower socio-economic status have better access to green space in two UK cities and the same was found in Perth, Australia, by Giles-Corti and Donovan (2002).

In the present study, we had no information about which green space the respondents were thinking of when they answered the questionnaire, which means that we can not draw conclusions about the effect of the quality of a green space on the frequency of use. It seems logical to assume that people are willing to travel a bit further to a very attractive green space and a relevant topic for further research would therefore be to find out if and how the attractiveness of green space affects the frequency of use. Developing a method to assess the attractiveness of green space as experienced by the users, is another issue worth exploring. Inspiration can most likely be found in the Spaceshaper approach developed in the UK by the Commission for Architecture and the Built Environment (2007). The Spaceshaper approach includes, e.g. a standardized quality assessment to be conducted jointly by all stakeholders that utilise and manage green space.

Green space is clearly a much used leisure opportunity, but how does it compare to other leisure opportunities when it comes to public funding? Calculating 'costs per visit' to a green space, paid by the tax-payer, would be an interesting next step that could further qualify a policy debate on spending of public funding on leisure and cultural activities.

4.4. Discussion of methodology

A major strength of the present study is that it is based on a large national representative sample. We have no knowledge of other nationwide studies looking into the use of green space with such a large number of respondents. The present study makes it possible to draw general conclusions about the use of green space of the entire adult Danish population, and the factors influencing this use.

In the current study we have chosen to ask respondents to estimate the distance to their nearest green space, which seems to be a better predictor for the frequency of use than the objectively measured distance (e.g. Scott et al., 2007), most likely because it reflects the respondents' opinion and knowledge of the green space. If a green space is well-known and well-liked, respondents are likely

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to underestimate the distance, if it is less-known and disliked, distance is likely to be overestimated (Scott et al., 2007).

A possible limitation of this study could be the relatively high non-response rate (48%) and, for that reason, non-response analyses were carried out. The analyses showed that the non-response was particularly high among young men and among the elderly. In order to evaluate the effects of non-response on the estimates in the present study, some central indicators (combined school and vocational education, long-standing disease and self-rated health) from the personal interview questionnaire were selected to compare the individuals who completed the self-administered questionnaire with those who did not complete the self-administered questionnaire. The analyses showed that the frequencies (prevalence) are, overall, similar in the two groups and the small differences do not seem to alter the total prevalences substantially (data not shown). However, the prevalence of individuals with a high education and a very good or good self-rated health was somewhat lower among individuals that did not return the self-administered questionnaire. Overall, there is no indication that non-response has seriously biased the results of the present study.

Another possible limitation of our questionnaire could be the use of different types of green space without presenting the respondents with clear definitions of these different types. This means that we do not exactly know when respondents identified a green space as being a certain type; i.e. we do not exactly know when is a park seen as a park, or a forest as a forest.

5. Conclusions and recommendations

Distance to green space is not a limiting factor for 66.9% (about 3.6 million persons) of the Danish population and for that reason a general strategy aimed at providing more green space close to people will probably not increase the use of green space. We therefore recommend a more site specific approach that builds on a thorough analysis of a neighbourhood or city, its population, and the available green spaces, before deciding on a viable strategy to increase the use of green space. A more active use of population demographics and background characteristics for surrounding neighbourhoods could be helpful when planning and managing green space.

However, city planners should continue to take the distance to green space into consideration, especially for new residential areas, in areas with many residents with limited mobility, and in larger cities where distance is more likely to be a limiting factor. In existing neighbourhood innovative solutions are needed as adding more green space is often impossible, but more knowledge on possible solutions still needs to be gained.

Green space is a relatively cheap and much used cultural and leisure facility to the Danish population compared to other leisure and cultural opportunities. Calculating more precise cost per visit could be a relevant input to budget negotiations in any city as this could demonstrate that green space often delivers a lot for a relatively small budget.

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PAPER II

INFLUENCES ON THE USE OF URBAN GREEN SPACE – A CASE STUDY IN ODENSE, DENMARK

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Influences on the use of urban green space – A case study in Odense, Denmark

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ABSTRACT

Increasing the use of urban green space has appeared on the political agenda, primarily because increased use is expected to improve the health and well-being of the urban population. Green space is contributing to restoring mental fatigue, serving as a resource for physical activity, reducing mortality and reducing the level of stress.

However, knowledge and experience on how to implement this agenda are scarce. In this paper, we use a socio-ecological model as framework when studying influences on the use of respondents' nearest urban green space in the Danish city of Odense. Data were obtained from a survey sent to 2500 randomly selected adult residents within the central part of the city. We tested the relative importance of different factors on the frequency of use of the nearest urban green space by using a multivariate logistic regression model. The results show that almost half of the respondents did not use their nearest green space the most. Whether or not respondent used their nearest green space most depends primarily on area size, distance to the area and factors that are likely to express a reduced mobility; old age, young children and poor health.

If the nearest urban green space also is the most used green space, having a dog is the only factor that significantly increases the frequency of use. Further research is needed to determine what it is that makes people use an area more, if the basic conditions of a reasonable size (> 5 ha) within a reasonable distance (< 600 m) are fulfilled.

Introduction

The amount of green space close to where people live has a significant relation with their perceived health (Maas et al., 2006). This relation might be explained by the fact that increased presence of green space is likely to increase the use of it, which in turn seems to promote various aspects of health. Green space is suggested to promote health by restoring from mental fatigue (Kaplan, 2001), serving as a resource for physical activities (Björk et al., 2008), and reducing mortality (Mitchell and Popham, 2008). Furthermore, various studies have labelled green space as a resource that helps reduce stress levels (e.g. Grahn and Stigsdotter, 2003; Ulrich, 2006; Nielsen and Hansen, 2007).

The relation between green space and health is also becoming visible on political agendas. Many recent national and local health policies, as well as city planning policies, are mentioning the positive effects of the use of green space (e.g. Aarestrup et al., 2007). Some of these policies include clear aims for increasing or improving the use of green space, as primary means of utilising the health benefits from green space (e.g. Public Health Office Copenhagen, 2006). However, translating these aims into concrete actions for city planning, or green space management is challenging at best. What can, or should, be done by city planners and green space managers to improve the use of green space? Which factors are influencing the use of green space, and which of these factors can city planners and green space managers actually influence?

A socio-ecological approach

Within the field of leisure research (Raymore, 2002), physical activity research (Owen et al., 2004), and active living research (Sallis et al., 2006), the so-called socio-ecological approach is widely used as framework to help structure and understand factors influencing human behaviour. This approach is based on the concept that one can only understand human behaviour when understanding a person's interactions with his or her physical and socio-cultural surroundings (Raymore, 2002). In a socio-ecological

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model, various levels of influence on a person's behaviour are distinguished that, according to Giles-Corti (2006), can be divided into individual factors (e.g. age, education, personal experiences, friends, family) and environmental factors (e.g. physical environment, cultural environment, policy environment).

Studying the use of urban green space could be part of all three above-mentioned scientific fields, and for that reason we have chosen to use a socio-ecological model as framework for understanding the use of urban green space. The behaviour 'use of urban green space' can be seen as the result of individual factors, the physical environment and various interactions between individual factors and environmental factors.

Distance is often mentioned as the main environmental factor influencing the use of green space (e.g. Coles and Bussey, 2000; Van Herzele and Wiedemann, 2003; Giles-Corti et al., 2005), and a distance of 300–400 m is seen as a typical threshold value after which the use frequency starts to decline (Grahn and Stigsdotter, 2003; Nielsen and Hansen, 2007). Other environmental factors such as size of the green space, presence of facilities and possibility for activities are also thought to have an influence on the use of urban green space (Van Herzele and Wiedemann, 2003; Bedimo-Rung et al., 2005; Giles-Corti et al., 2005).

Furthermore, individual factors such as age, education and gender are likely to have an impact on use of green space (Payne et al., 2002; Roovers et al., 2002). But the relatively unchangeable character of these individual factors has lead to an increased focus on the environmental factors that can be changed (Bedimo-Rung et al., 2005).

From the perspective of city planners or green space managers, focusing on the possible changes in the physical environment seems obvious. However, when making changes in the physical environment it is important to realise that each person has different preferences and needs. Raymore (2002) mentions that any possible environmental constraint or facilitator must be perceived as such before it becomes a constraint or facilitator in reality. Environmental factors constraining the use for one person might stimulate use for another person and vice versa. Therefore, it is essential to understand the individual factors that influence the use and perception of a specific urban green space before planning any physical changes in this green space. E.g. before renewing play equipment on a playground it is essential to know if its lack of use is due to the worn-down play equipment, or due to the fact that the children in the neighbourhood have become older and prefer a whole different type of playground.

All factors influencing the use of green space can, and will, interact with each other and a solution that might work in one situation might not work in another situation; each city has its own structure, each green space its own characteristics and each neighbourhood its own inhabitants. For that reason, city planners and green space managers need to be aware of possible site-specific solutions in addition to general recommendations.

The objective of this study is to describe the use of urban green space and understand which factors are correlated with this use. Based on the socio-ecological model and the above-mentioned literature we expect to find associations for both individual and environmental factors.

To address this objective we posed the following research questions:

- Are environmental factors, such as size and distance, related to the use of the urban green space?
- Are individual factors, such as age and education, related to the use of the urban green space?
- How do the different factors interact?

Methods

We have chosen to conduct a survey within a relatively small case study area in one city. The combination of a small case study area and a relatively large survey allowed us to generate quantitative data with a high level of detail. In this way, it becomes possible to study the effect of many factors simultaneously and, according to Flyvbjerg (2001) it will be possible to draw parallels to other cases based on this due to the high level of detail and in-depth understanding.

Definitions

Urban green space (UGS) is in this paper defined as all publicly owned and publicly accessible open space with a high degree of cover by vegetation, e.g. parks, woodlands, nature areas and other green space. It can have a designed or planned character as well as a more natural character. Only areas that can be entered and used from 'within' are included.

Use of urban green space is in this paper defined broadly as any sort of visit to an urban green space, without looking at the duration of the stay, the reason for visiting or the activity done while visiting; e.g. passing through on the way to a destination is also counted as use.

Study area

The data used in this paper were gathered in Odense, the third largest city of Denmark with a population of 187,929 (Statistics Denmark, 2009). Odense was selected for our survey because of its image of being a 'green city' and the availability of detailed information on all UGS; it was chosen as a 'critical case' (Flyvbjerg, 2004). The aim with selecting a critical case is to be able to make logical deductions of the type 'if this is (not) valid for this case, then it applies to all (no) cases' (Flyvbjerg, 2004). The central part of the city was selected because of the large variation in housing types and UGS types that can be found here. Housing types range from apartment buildings in many types and forms, to many types of semi-detached houses and other smaller single family housing, to large villas. Many residents living in apartments have access to a common private garden and most residents living in a house have their own garden. UGS range from historic gardens and parks with a very high maintenance level, to neighbourhood parks, to larger recreational parks, including one of the city's largest woodland areas. The large variation was chosen intentionally to increase the possibility to generalise the result from this study to other Danish cities.

The border of the case study area was created by drawing a circle with a 2 km radius with the main railway station as central point (see Fig. 1). Approximately 35,000 inhabitants are living within this area and have access to 53 UGS. Six of these are more than 5 ha, 15 are between 1 and 5 ha and the remaining 32 UGS are less than 1 ha. We only included UGS that have at least one entrance and can actually be visited.

Data collection – questionnaire

In October 2005, an 18-page postal questionnaire was sent to 2500 residents aged 18–80, randomly selected by Municipal Statistics Department in Odense. After sending two reminders, 1305 persons (52.2%) returned the questionnaire. The questionnaire used in this study took inspiration from the one used by Tyrväinen et al. (2007) in Helsinki, Finland. The survey furthermore incorporated a number of questions used in an earlier Danish nationwide survey on the use of UGS (Nielsen and Hansen, 2007), and a similar Swedish study (Grahn and Stigsdotter, 2003). A pilot test was performed on a selected group of respondents, who were not part of the sample, and their feedback

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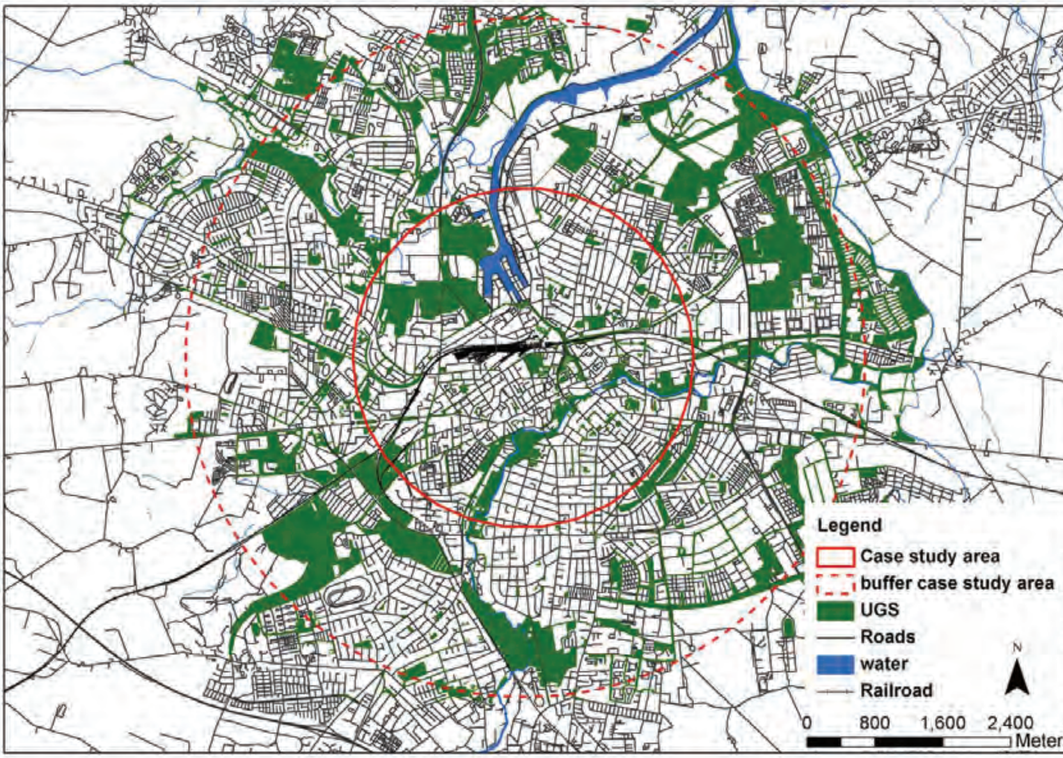

Fig. 1. . Case study area showing all urban green spaces within the area, as well as in a 2 km buffer surrounding it.

was incorporated in the final version of the questionnaire before it was distributed. The survey was approved by the Danish Data Protection Agency.

Based on previous studies (e.g. Grahn and Stigsdotter, 2003; Nielsen and Hansen, 2007), we expected a large influence of distance on the frequency of use of UGS. The respondents were asked about the use frequency of their nearest UGS on a 6-point scale ranging from never to daily; the answers were dichotomised for visiting more or less frequent than once a week.. The respondents were furthermore asked to estimate the distance to their nearest UGS as well as their most used UGS, in 8 categories with 100, 300, 600 m, 1, 2, 5 and 10 km as boundaries. UGS was defined as green space, parks, woodlands and nature areas and use of UGS was defined as any type of visit to UGS. The respondents evaluated their own health status on a 5-point scale: poor, less good, good, very good and excellent. They were also asked about more general demographic information such as age, gender, number of children and level of education.

To be able to combine the questionnaire data with the other data, the addresses of all respondents have been added as anonymised address points in a Geographic Information System (GIS). The questionnaire data were then linked to each address point enabling analyses that utilise both questionnaire data and objective UGS data.

Collection of data on green space

All data on UGS were compiled using a GIS system (ArcGIS 9.3). The Municipality of Odense uses a GIS-based green space management information system that contains detailed information on all UGS in the city including information on size, type and distribution of vegetation and available facilities. The information available in this system was used for this study. All UGS within a 2 km buffer surrounding the case study area was included in all analyses to make sure that the nearest UGS was part of the analyses, also for respondents living close to the border of the case study area. Data on 160 UGS with a total of 870 entrances were included in the analyses. All UGS were categorised by size in four classes: <1, 1–2, 2–5 and >5 ha.

A new GIS layer containing all entrances to all UGS was created based on the municipality data, and verified during field visits. The data on the size of the UGS, type and distribution of vegetation and available facilities was linked to each entrance. Furthermore, the distance from each respondent to the nearest entrance to a UGS was calculated. The Euclidian distance ('as the crow flies') was analysed using a so-called "Near analysis" in ArcGIS between the respondent home and the nearest entrance to a UGS. The distance over the network was calculated with ArcGIS Network Analyst using a network dataset with all roads and trails accessible for pedestrians and cyclists available from The National Survey and Cadastre Agency of Denmark.

Statistical analysis

Multiple logistic regression analysis was used to investigate the association between potential predicting factors and visits to the nearest UGS at least once a week between April and October.

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The results are presented as odds ratios (OR) with 95% confidence intervals (CI). Goodness-of-fit of the models was assessed by the Hosmer–Lemeshow test (Hosmer and Lemeshow, 2000), and the tests indicated that the models fit the data adequately. Statistical analyses were performed using SPSS version 16.

Results

Respondents

As expected from the city centre of a university city, we found that our respondents are not representative for the Danish population, with 35.8% of the respondents being between 17 and 29 years, versus 25.5% in Odense, versus 19.9% in Denmark. Furthermore, our respondents clearly have a longer education than average with 17.6% of our respondents having at least a master's degree, compared to 5.1% and 5.5% for Odense and Denmark, respectively. A similar population can probably be found in the central parts of larger cities with a university or other higher educational institutions.

Distance to green space and frequency of use

The nearest UGS is visited at least once a week by 56.2% of the respondents (see Table 1), compared to 89.5% visiting their own garden weekly (n=484), or 62.1% visiting their common private garden (n=693). 9.6% of the respondents visit their nearest UGS every day and only 0.8% never visit it.

Table 1
Frequency of visits to the nearest green space, for all respondents (N=1305), to own garden (only respondents that have their own garden, n=484) and/or common private garden (n=693).

	Nearest UGS (N=1305)	Own garden (n=484)	Common private garden (n=693)
Daily	9.6	73.6	28.3
4–5 times a week	12.0	9.5	13.9
1–3 times a week	34.6	6.4	19.9
1–3 times a month	28.7	1.7	10.7
Rarely	13.0	1.9	21.4
Never/no access to	0.8	5.0	4.6
No answer	1.3	2.1	1.3

In % of respondents.

As can be seen in Table 2, 62.8% of the respondents estimate that they live within 300 m of an UGS. For the objectively measured distances, measured in GIS, 68.9% live within 300 m of the nearest UGS measured over a network of roads and trails accessible for pedestrians. For the Euclidian distance the number is 91.6%. However, if we take area size into account the picture changes; e.g. 41.1% has an UGS of at least 1 ha within 300 m, while only 16.1% has an UGS of at least 5 ha within 300 m. One hectare is mentioned by Van Herzele and Wiedemann (2003) as the minimum size for neighbourhood green, 5 ha is mentioned as the minimum size for a park with city quarter appeal. However, Van Herzele and Wiedemann (2003) mention that these numbers were derived from planning guidelines and not the result of empirical studies.

Relation between frequency of use and distance

As expected, we found a distance-decay in use of UGS. If the self-estimated distance to the nearest UGS is more than 100 m, the number of respondents that use this UGS daily drops to 7.8% compared to 15.4% daily visitors for respondents living within 100 m (data not shown). To determine which distance measure is best at predicting the frequency of use of the nearest UGS, we performed three separate logistic regression analyses with the three measures for distance to the nearest UGS as predictor. For respondents who evaluated the distance to their nearest UGS to be less than 100 m, compared to those who thought the distance to be more than 300 m, the self-evaluated distance is the best predicting factor with an OR of 1.85. The OR for Euclidian and network distance were 1.39 and 1.47, respectively. All three measures return significant odds ratio's, but the Hosmer and Lemeshow (2000) test for goodness of fit indicates that the models for Euclidian and network distance are poor fitting

Table 3
Percentage of respondents not using their nearest UGS most (n=1204).

Distance to nearest UGS (estimated by respondents)	% not using nearest UGS most
0–100 m	51.2
100–300 m	48.8
300–600 m	46.7
0.6–1.0 km	50.0
1–2 km	40.7
Total for all distances	46.3

Table 2
Distance from respondents to green space.

	Distance estimated by respondents		Distance calculated in GIS			
	Distance to		Euclidian distance	Network distance to		
	Nearest UGS	Most used UGS	Nearest UGS	Nearest UGS	Nearest UGS >1 ha	Nearest UGS >5 ha
0–100 m	31.4	17.1	32.7	18.0	9.1	3.5
100–300 m	31.4	18.9	58.9	50.9	32.0	12.6
300–600 m	23.3	17.9	8.4	29.3	38.6	21.1
0.6–1.0 km	10.0	14.2		1.8	20.2	36.8
1–2 km	2.5	11.1				26.0
2–5 km	0.2	7.0				
5–10 km		2.7				
>10 km		3.7				
Do not know	1.1	7.4				

In % of respondents (n=1305).

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Table 4
Odds ratio for potential predictors of the nearest UGS also being the most used UGS.

	%	Sig.	Odds ratio	95.0% C.I.for EXP(B)		N
				Lower	Upper	
Individual factors						
Age						
17–29	50.8	0.35				413
30–39	52.2	0.53	0.90	0.64	1.26	249
40–49	51.4	0.44	0.87	0.60	1.25	172
50–59	60.2	0.22	1.27	0.87	1.85	163
60–69	58.9	0.61	1.12	0.72	1.76	105
70–81	68.1	0.17	1.62	0.82	3.19	45
Gender						
Women	54.5					609
Men	53.1	0.39	0.90	0.71	1.15	538
Children under 6						
No	52.5					994
Yes	61.1	0.01	1.73	1.17	2.56	153
Self-evaluated health						
Less good	64.0	0.01				71
Good	54.8	0.01	0.59	0.39	0.90	429
Very good	51.6	0.00	0.51	0.34	0.78	647
Dog						
No dog	52.1					1020
Dog	66.4	0.00	1.94	1.29	2.92	127
Education						
< 10 years	53.3	0.68				118
10–12 years	52.0	0.99	1.00	0.67	1.48	390
> 12 years	54.7	0.57	1.12	0.76	1.63	639
Environmental factors						
Size nearest UGS						
< 1ha	47.6	0.00				612
1–2ha	53.5	0.30	1.31	0.78	2.20	68
2–5ha	55.5	0.01	1.53	1.12	2.09	242
> 5ha	68.4	0.00	2.55	1.82	3.58	225
Self-evaluated distance to nearest UGS						
< 100 m	48.8	0.00				373
100–300 m	54.6	0.09	1.30	0.96	1.74	366
> 300 m	57.2	0.00	1.78	1.32	2.40	408

Table 5a
Odds ratio for potential predictors of the nearest UGS being used at least once a week, for respondents for whom the nearest UGS is NOT the most used UGS.

	%	Sig.	Odds ratio	95.0% C.I.		N
				Lower	Upper	
Individual factors						
Age						
17–29	47.4	0.05				203
30–39	55.7	0.82	1.06	0.65	1.74	118
40–49	47.7	0.27	0.74	0.43	1.27	85
50–59	60.6	0.22	1.45	0.80	2.62	65
60–69	72.7	0.01	2.69	1.27	5.67	44
70–81	46.7	0.82	0.87	0.28	2.69	14
Gender						
Women	52.2					276
Men	53.6	0.81	0.96	0.67	1.37	253
Children under 6						
No	51.1					469
Yes	65.1	0.10	1.70	0.91	3.18	60
Education						
< 10 years	62.5	0.16				54
10–12 years	49.7	0.81	0.93	0.50	1.70	186
> 12 years	44.9	0.31	1.35	0.75	2.43	289
Self-evaluated health						
Less good	48.1	0.01				24
Good	46.6	0.01	0.42	0.22	0.79	194
Very good	57.1	0.26	0.69	0.37	1.31	311
Dog						
No dog	51.7					488
Dog	64.4	0.16	1.66	0.82	3.35	41
Environmental factors						
Size nearest UGS						
< 1 ha	47.5	0.12				295
1–2 ha	54.5	0.48	1.32	0.61	2.84	36
2–5 ha	57.9	0.25	1.32	0.82	2.12	134
> 5 ha	67.6	0.02	1.95	1.10	3.45	153
Self-evaluated distance to nearest UGS						
< 100 m	46.4	0.01	1.84	1.18	2.87	188
100–300 m	47.9	0.73	1.08	0.70	1.68	168
> 300 m	57.7	0.01				173

(P=0.04 and 0.06, respectively), whereas the model for self evaluated distance has a P-value of 0.65, indicating a good model fit.

However, we found a high percentage of respondents that does not use their nearest UGS most, see Table 3. On average 46.3% of the respondents are willing to go further than their nearest UGS to visit their most used UGS.

Relation between use of the nearest green space and potential predicting factors

To get a better understanding of what it is that makes the nearest UGS also the most used UGS, we performed a logistic regression analysis with ‘most used UGS is nearest UGS’ as dependent factor. The *size of the nearest UGS* seems to be a good predictor; a larger area is more likely to be the most used area than a smaller area. Table 4 shows that the odds ratio (OR) for using their nearest UGS being the most used UGS is 2.54 times higher for UGS over 5 ha compared to areas under 1 ha. Furthermore, *distance to the nearest UGS* has an effect, the further away the nearest UGS is, the higher the odds for using this UGS most (OR 1.76 for areas > 300 m). *Having a dog* or a *child under 6 years of age* also increases the odds that the nearest UGS is the most used UGS (OR 1.90 and 1.78, respectively). Respondents with a very good health are less likely to visit their nearest UGS most compared to those with a *less good health* (OR 0.52). For respondents aged 70–81 the OR is 1.48, indicating that the nearest UGS is often the most used UGS for people in this age group, but this is not significant in this model.

Factors influencing the frequency of use of the nearest green space

The unexpected high percentage of respondents that does not use their nearest UGS most is likely to disturb the results of a logistic regression analyses with the frequency of use of the nearest UGS as dependent factor. It seems likely that different factors will influence the frequency of use depending on whether or not the UGS is the most used UGS or not. For that reason, we decided to split our data-set into two parts, with separate analysis for respondents that do use their nearest UGS most and those that do not (Tables 5a and b). Table 5a shows that *age, self evaluated health* and *distance to the nearest UGS* have a significant predicting value for the frequency of use of the nearest UGS for those respondents that have another UGS they use more frequently.

The percentage of respondents that use their nearest UGS at least once a week is clearly higher for those that use this area most (Table 5b), but the same logistic regression model has just one significant predictor for visiting it at least once a week; *having a dog* (OR 2.66). None of the other factors we included in our model have a significant effect if the nearest and most used UGS is one and the same.

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Table 5b
Odds ratio for potential predictors of the nearest UGS being used at least once a week, for respondents for whom the nearest UGS is also the most used UGS.

	%	Sig.	Odds ratio	95.0% C.I. Lower	95.0% C.I. Upper	*N*
Individual factors						
Age						
17–29	60.0	0.61				210
30–39	61.7	0.96	0.99	0.60	1.61	131
40–49	68.8	0.42	1.25	0.72	2.16	87
50–59	74.0	0.15	1.48	0.86	2.55	98
60–69	65.1	0.80	0.92	0.50	1.69	61
70–81	71.9	0.34	1.51	0.65	3.48	31
Gender						
Women	63.3					333
Men	66.8	0.43	1.15	0.81	1.63	285
Children under 6						
No	64.9					525
Yes	63.6	0.65	1.13	0.67	1.90	93
Education						
< 10 years	64.1	0.81				64
10–12 years	64.1	0.56	0.86	0.51	1.45	204
> 12 years	65.0	0.83	0.94	0.57	1.58	350
Self-evaluated health						
Less good	58.3	0.64				47
Good	63.2	0.60	1.15	0.67	1.98	235
Very good	66.8	0.36	1.28	0.75	2.19	336
Dog						
No dog	61.8					532
Dog	83.1	0.00	2.66	1.46	4.84	86
Environmental factors						
Size nearest UGS						
< 1 ha	59.8	0.20				295
1–2 ha	60.5	0.69	0.86	0.41	1.81	36
2–5 ha	69.7	0.13	1.43	0.90	2.28	134
> 5 ha	70.6	0.09	1.48	0.94	2.33	153
Self-evaluated distance to nearest UGS						
< 100 m	70.2	0.24	1.29	0.84	2.00	185
100–300 m	65.4	0.92	0.98	0.65	1.48	198
> 300 m	59.9	0.39				235

Discussion

Factors influencing the use of green space

Many factors influence the use of UGS and it is still not entirely clear which mechanisms can help to explain this. The choice between different UGS, with different functions, seems to be important as different UGS seem to complement each other. UGS also seem to complement private or common gardens; garden owners visit UGS more frequent, but the significance of having a garden disappeared from our models as soon as we included the background factors age and education indicating that having a garden is strongly related to these factors. Not having a garden is not compensated by visiting UGS more often, which might be explained by the assumption that garden owners are more interested in spending time outside; in their own garden for some activities and in UGS for other activities. Grahn and Stigsdotter (2003) and Maat and de Vries (2006) report similar findings.

Based on earlier studies that report a clear effect of distance on use (e.g. Grahn and Stigsdotter, 2003; Nielsen and Hansen, 2007), we assumed that the nearest UGS would be the most used UGS for most respondents, hence many of our questions were related to use of the nearest UGS. However, as this assumption proved to be wrong we now know that it would have been better to ask about the frequency of use of all different UGS that respondents use, and get as much detail as possible on the use of these areas and reason for this. The difference in frequency of use of the nearest UGS is confirmed when comparing 13.2% daily visits for respondents who state that it is their most used UGS with 6.1% daily visits for respondents that not use the nearest UGS most.

Size of the nearest UGS is an important factor influencing whether or not this UGS will be the most used UGS. Also distance has a significant effect, the further away, the larger the odds it will be the most used UGS. Personal factors that are likely to limit mobility, having young children, an old age or a poor health, have an effect. It seems that if people have a larger UGS within a reasonable distance as well as a smaller UGS close by, and there are no personal factors that reduce their mobility, they will use the larger UGS more often than they use their nearest UGS. This is important to realise when UGS need to be made accessible for all, including weaker groups in society.

In a theoretical situation we expect that the frequency of use will increase with increased size of the available UGS, if this UGS is not too far away. Based on an interpretation of a GIS map showing which UGS are both nearest and most used, it seems that an UGS needs to be at least 5 ha to attract visitors to go past a smaller UGS closer by, and that this ‘pull effect’ starts to decline if the UGS is more than 600 m from the resident’s home. Our data did not allow for a statistical test to confirm or reject this hypothesis as we only have data on the frequency of use of the nearest UGS, and not for the most used UGS. A relation between UGS size and distance visitors are willing to travel to it is not unfamiliar to many city planners. In the 1970s and 1980s, several national and local green space planning norms have been based on this concept, and more recent has it e.g. been used by Van Herzele and Wiedemann (2003) to assess the availabilities of UGS in four Belgium cities. However, to our knowledge this relation has not been tested scientifically. Further research is therefore needed to test if our hypothetical model can be supported by scientific evidence.

If the nearest UGS is also the respondents’ most used UGS, it is difficult to predict the frequency of use with the factors we tested. Size, distance, personal factors, they all have little or no effect. Only having a dog makes a significant difference. We tried including various other environmental factors such as percentage cover by different vegetation types, diversity of the area, presence of facilities and area shape, in all our logistic regression models. We also tried including other personal factors such as income, marital status, profession, level of stress, preferences for different activities, preferences for different UGS elements, importance of maintenance and view on nature. But including each of these factors resulted in a reduced model fit while none of them had a significant effect on the frequency of use. For that reason we chose not to include them in the final models presented in this paper.

Time spent in urban green space

This paper has its focus on the frequency of use of UGS and in the presented study we did not use the factor ‘time spent in UGS’ actively. Our questionnaire did not include a question about time spent per visit, but only a question about time spent in UGS on a weekly basis. Other authors have talked about a so-called compensation theory that suggests that respondents chose fewer, but longer visits if the UGS is further away, and more, but shorter visits is the green space is close by, equalising the total time spent in UGS (e.g. Grahn and Stigsdotter, 2003). As we do not know the time per visit we cannot directly test this theory. However, in a logistic regression analysis (not shown) using the same factors as included in our other analyses we can see that spending at least 1 h per week in the nearest UGS is significantly related to distance

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with an OR of 1.25 for areas less than 100 m from the respondent, compared to UGS more than 300 m away. This seems to indicate that the compensation theory does not hold in our case. The only other significant factor in our model is having a dog with an OR of 2.71. Rather surprisingly also area size is not significant, even though the ORs are around 1.3. This might indicate compensation behaviour, if the area is larger there are fewer longer visits, if it is smaller, there are more, shorter visits.

Distance as predicting factor for use

As a result of our study setup it was possible to compare three ways of evaluating the distance from each respondent to the nearest UGS: we objectively measured the Euclidian distance as well as the distance using roads and trails with help of GIS, and we asked the respondents to estimate the distance. Self-estimated distance is a better predictor for the frequency of use of urban UGS than the objectively measured distance, which confirms similar findings by Scott et al. (2007). For a city planner this is a difficult finding to deal with as it reduces his or her possibilities to plan based on objective distance measurements. It is therefore important to realise that self-estimated distance most likely is a better predictor because it reflects the respondents' opinion and knowledge of the UGS. If an UGS is well known and well liked, respondents are likely to underestimate the distance, if it is less-known and disliked, distance is likely to be overestimated. E.g. launching an information campaign or a public involvement campaign to make an UGS more well known and well liked can therefore be a planning tool to reduce the experienced distance, and with that increase the use.

Discussion of methodology

A major strength of the present study is that all data used has a geographic reference, providing a unique insight in how different factors influence the use of UGS on a specific location. Furthermore, the relatively large number of respondents can be seen as strength.

The possibility of mixing questionnaire data with GIS data is a strength of this paper, but there is also a risk of misinterpretation as we do not know for sure that the UGS that is objectively the nearest also is the one that respondents refer to when mentioning their nearest area. Nor do we know for sure that all UGS that are mentioned in the municipal GIS, are recognised as such by the respondents. Especially for the many small UGS, it seems a bit questionable if they were always recognised as usable UGS, even though we only included UGS in our analyses that had at least one entrance and could be visited.

Another possible limitation of this study could be the relatively high non-response rate (47.8%) and, for that reason, non-response analyses were carried out. A relatively high non-response means that there is a risk that our respondents do not fully represent the population as those actually using urban UGS might be more inclined to return a questionnaire on this topic. The analyses showed a slight overrepresentation of women among our respondents, 53.6%, compared to 49.2% among the sample. It furthermore showed a slight underrepresentation of persons between 17 and 29 years old; 35.8% among the respondents versus 39.7% among the sample. But these differences are not significant (data not shown) and therefore not likely to have had a large impact on our results.

Our case was selected as a 'critical case' and not as a 'representative case', which is important to keep in mind when generalising from the results. The high percentage of well-educated, healthy, young persons in our study area, combined with the high number of close by UGS makes the central part of Odense an area that is likely to have a relatively high use of UGS. This made Odense a good critical case as the use of UGS is not likely to be limited by lack of available green space, or lack of motivation of the respondents to use it.

Future research perspectives

Even though we included many different factors in our analysis, we did not find a good predictor for the frequency of use of the most used UGS, if this also is the nearest UGS. As mentioned, size and distance have a significant effect on whether or not an UGS is a respondent's most used area, but if the basic conditions of a reasonable size (>5 ha) within a reasonable distance (<600 m) are fulfilled we do not really know what it is that influences the frequency of use. Based on previous studies (e.g. Roovers et al., 2002) we had expected that individual factors such as age and education would be related to the frequency of use, but they surprisingly do not significantly do so in our model. We also expected an effect of distance, but apparently we need to look at other factors if we want to be able to understand the frequency of use of these UGS. Perhaps there is a quality in these areas that visitors can recognise, but that is not captured very well by the factors we included in this study. Or possibly we need to look more at the possibilities for activities on offer in the available UGS, versus the desired activities. Or we might have missed some important personal factors that can help explain the respondents' behaviour. In a next study we will try to develop a method to assess the attractiveness of UGS as experienced by the users to try and find a better factor to predict the frequency of use of UGS.

Finally, the availability of various UGS within a reasonable distance from the respondent's home means that they can choose which UGS they want to use and exploring the factors that influence this choice is a topic we would like to study in the future.

Concluding remarks

What can a city planner or green space manager learn from our study? First of all it is important to stress that many factors that cannot be influenced by city planners or green space managers have a large effect on the use of UGS. Therefore a good neighbourhood analysis that reveals which factors are limiting the use of a specific UGS, is essential if changes in the UGS are to have a positive effect on the use of it.

Each UGS is unique, with its own possibilities and own users. It is necessary to have a good insight in who the neighbourhood residents are and what their wishes and preferences are, as well as an insight in how other UGS in the neighbourhood look and which possibilities they offer. Second, it is important to recognise that providing more UGS within a short distance from residents is not always the solution to increase the use of UGS, which is good news for planners as adding new UGS close to residents often is difficult. However, for residents that are likely to be limited in their mobility by having young children, an old age or a poor health, having an UGS close by is important for their frequency of use. Third, when looking at the nearest UGS, it is important to be aware of their size; small areas will be used less. It is therefore important for city planners to find a good balance between providing both smaller and larger UGS within a reasonable distance; a neighbourhood with many small UGS will not fulfil all user needs, nor will a neighbourhood with only one large UGS that is more than 600 m from some residents. Finally, and this is particularly relevant for green space managers,

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if the basic conditions of a reasonable size (> 5 ha) within a reasonable distance (< 600 m) are fulfilled, we did not find the answer to what it is that makes people use these areas more. At the moment we suspect that experienced qualities and possibilities for desired activities are part of the explanation, but more research is needed to get a better answer.

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PAPER III

BEYOND DISTANCE: ASSOCIATION OF PHYSICAL ACTIVITY AND URBAN GREEN SPACE

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BEYOND DISTANCE: ASSOCIATION OF PHYSICAL ACTIVITY AND URBAN GREEN SPACE

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ABSTRACT

Using a sample of 1305 Danish adults and detailed descriptions of urban green space (UGS) we examined the association between UGS and physical activity (PA) in general, as well as PA in the nearest UGS. No association between PA in general and size of, distance to, and number of features in the nearest UGS was found and the amount and number of UGS within one kilometre revealed no association either. For PA in the nearest UGS positive associations with size, walking/cycling routes, wooded areas, water features, lights, pleasant views, bike rack and parking lot were found. This indicates that PA in an UGS might be stimulated by providing these features there.

Key words: active living, GIS, green space management, health design, landscape planning, physical activity

INTRODUCTION

Physical activity and active living

Physical activity (PA) in everyday life is associated with a range of health benefits. Overall mortality and chronic diseases such as coronary heart disease, type 2 diabetes, high blood pressure, colon cancer as well as mental ill-health are all linked with a low level of PA (e.g. Bassuk & Mansson 2005; Bauman et al., 2002). Increased physical inactivity is recognised as an important societal problem, and increasing the general level of PA has become a major focus of many health promotion strategies world wide. Two thirds of the adult population does not reach the levels of PA recommended by the World Health Organisation (Edwards & Tsouros, 2006). This has, among other, resulted in the emergence of an "active living movement". In the past decades, a large number of researchers have explored how "active living" can be stimulated and this has resulted in a growing understanding of the factors that influence "active living". A frequently used model to help explain human behaviour in this context is the socio-ecological model. A comprehensive version of this model was developed by Sallis et al. (2006). In a socio-ecological model, various levels of influence on a person's behaviour are distinguished that can be divided into individual factors (e.g. age, education, personal experiences, friends, family) and environmental factors (e.g. physical environment, cultural environment, policy environment) (Giles-Corti, 2006).

Environmental factors and PA

A number of review studies (Humpel et al., 2002; Owen et al., 2004; Saelens et al., 2003; McCorkmack et al., 2004; Heath et al., 2006) provide a good overview of the large number of studies that have explored the relation between PA and the physical environment, especially in the North America and Australia. These reviews report associations between the level of PA and environmental factors such as population density, land use, green space, recreation opportunities, sport facilities, infrastructure, aesthetics and safety.

A review by Kaczynski and Henderson (2007) included 20 studies published in the period 1998-2005 that specifically focused on the role of parks or urban green space (UGS) in stimulating PA. Nine of these studies reported positive associations, five reported mixed associations and six reported that the associations examined were not significant. Only two of these 20 studies were conducted in Europe. Foster et al. (2004) found that having a park within walking distance was positively associated with walking >150 minutes a week across the UK. Wendel-Vos et al. (2004) reported a positive association for cycling and the presence of parks within a 300m radius in

Maastricht, The Netherlands, but no association was found for walking. Since 2005, a number of European studies with a large number of respondents have been published in this field. In a study (n = 4 950) in the City of Norwich, UK, Hillsdon et al. (2006) found no relation between access to and quality of green space and recreational PA. In a national study (n = 4 899) in The Netherlands by Maas et al. (2008) no relation was found between the total amount of green space within a radius of one as well as three kilometre from each respondent and meeting the recommended levels of PA. A third study (n = 24 819) in Southern Sweden by Björk et al. (2008) did find a positive association between the presence of "recreational values" within 100 and 300 metres from peoples home and moderate PA, but this study excluded urban residents. The five above-mentioned European studies used different measures of PA, various definitions of UGS, and different methods to evaluate the distance to UGS, which makes it difficult to compare the results directly. But, it seems fair to say that the evidence for positive associations between UGS and PA in European cities is rather mixed. According to Kaczynski et al. (2009), this methodological variation is common for most research on proximity to UGS and PA, and this type of research has furthermore been limited by a lack of detail in measuring proximity to green space and a lack of detail in measuring PA, causing poor theoretical correspondence, and therefore mixed results.

To overcome these problems, Kaczynski et al. (2009) worked with three different measures of proximity to parks in a smaller study (n = 384) in Canada: the number of parks within 1km, the total amount (total surface area) of all parks within 1km, and the distance to the nearest park. The association between each of the three measures and PA in general, PA in the neighbourhood, and PA in parks was examined and the number of parks within 1km had a significant positive association with neighbourhood PA and park-based PA. Park area within 1km was significantly associated with total PA and park-based PA. Based on the same data, Kaczynski et al. (2008) also studied the association between park size, distance to the park and park features with park-based PA. In this study, a positive association between the number of features and PA in parks was found, especially the presence of paved trails was strongly associated with PA.

PA and UGS in Denmark

Also in Denmark there is a growing attention for UGS and its presumed positive effect on the general level of PA. Increasing the accessibility of UGS has become an accepted part of the health strategy for many Danish Municipalities (Aarestrup et al., 2007). The City of Copenhagen has for example recently adopted a new planning strategy that includes an aim of providing UGS within 400m for at least 90% of its population in 2015 (Public

Health Office Copenhagen, 2006). However, the number of studies in this field in Denmark is limited. Toftager et al. (submitted) found a positive relation between the distance to green space and the level of physical activity in a large national cross-sectional survey. However, this study did not include information on the characteristics of the green space.

Denmark is a good location for health studies that involve geographic locations as each Dane has a unique personal registration number that is linked to their address. This means for example that respondents can be randomly sampled within a specified geographic area, and that data can be drawn from Statistics Denmark.

Based on the inconclusive results from earlier international studies and lack of more detailed information in Denmark, our current study has as aim to test if an association between physical activity and the distance to the nearest green space, the size of the nearest green space, the features of nearest green space, and the amount of green space within a certain distance can be found. We use two types of PA; self-reported PA in general (at any location) and self-reported PA in the nearest UGS.

We wanted to answer the following research questions: 1) Is the number and total size of UGS in the neighbourhood related to PA? 2) Are the features of the nearest UGS related to PA in this UGS? And 3) Are the size of and distance to the nearest UGS related to PA in general and/or PA in the nearest UGS?

METHODS

To investigate the association between PA and UGS in more detail we have focused on generating data with a high level of detail for a relatively small study area in one city. This study design was chosen with the idea that we need a better insight into which factors are relevant to study in a Danish context before conducting a more representative study. We tried to combine promising measures of UGS and PA used in earlier research. We used a survey with randomly selected inhabitants to collect data on self reported physical activity; an expert registration of green space features; and an exact calculation of road distances to green space and size of green space in a Geographic Information System (GIS).

Definitions

Urban green space (UGS) is in this paper defined as all publicly owned and publicly accessible open space with a high degree of cover by vegetation, e.g. parks, woodlands, nature areas and other green space. It can have a designed character as well as a more natural character. Only areas that can be entered by users are included.

Physical activity (PA) is in this paper defined as the self-reported participation in organised or unorganised sport or exercise, both indoor and outdoors, at least once a week. Due to the formulation of the question PA was most likely interpreted by the respondents as more intensive recreational PA. The choice of once a week as lower limit is based on the pragmatic assumption that less frequent participation can not be seen as regular PA, but knowing that any amount of PA is thought to contribute to more active living.

Physical activity in urban green space is in this paper defined as the self-reported participation in sport or exercise taking place in the nearest UGS at least once a week.

Study area

The third largest city of Denmark, Odense, was selected as study area because of its image of being a “green and active city” (City of Odense, 2008) and the availability of detailed information on all UGS. The Municipality of Odense has a population of 187 929 as of January 2009 (Statistics Denmark, 2009). To increase the possibility to generalise based on the results from this study we selected the central part of the city because of the large variation in housing types and UGS types that can be found here. A circle with a two kilometre radius with the main railway station as central point was drawn as border of the study area (see figure 1). It is a relatively green area with a total of 53 UGS, but most UGS are small. Only two of these UGS are more than ten hectares in size, four are between five and ten hectares, 15 are between one and five hectares and the remaining 32 UGS are less than one hectare. The size categories are based on Van Herzele and Wiedemann (2003).

To make sure that all relevant UGS were part of the analyses, also for respondents living close to the border of the case study area, all UGS within a two kilometre buffer surrounding the case study area was included in the analyses. A total of 160 UGS with in all 870 entrance points were included in our analysis.

Study sample

In October 2005, an 18-page postal questionnaire was sent to 2 500 residents aged 18-80, randomly selected by Municipal Statistics Department in Odense. After sending two reminders, 1 305 persons (52.2%) returned the questionnaire. About 35 000 inhabitants between 18-80 years old live within the study area and a more detailed description of the respondents in the sample compared with the general population of Odense and Denmark can be

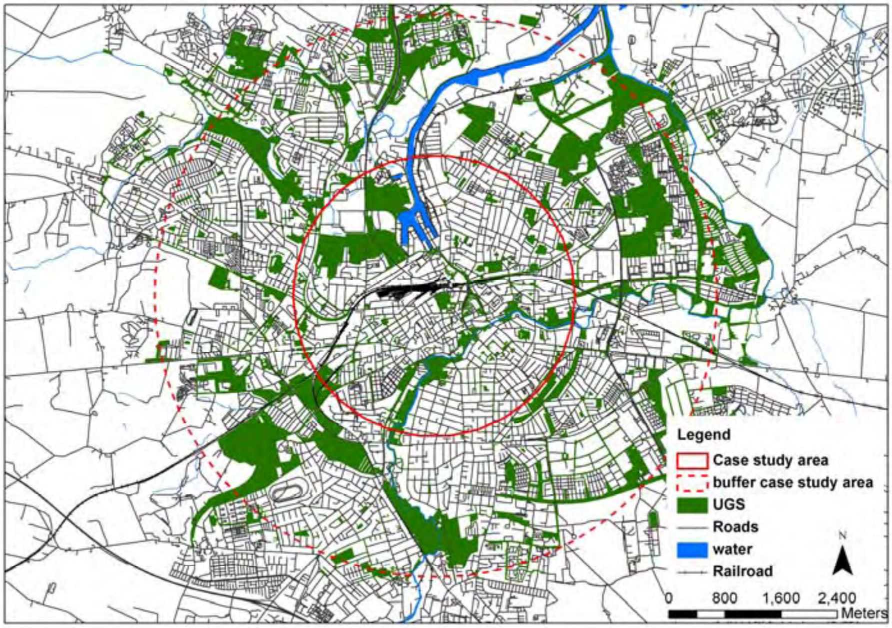

Figure 1. Study area showing all UGS within the area, as well as in a 2km buffer surrounding it.

seen in table 1. Numbers for Odense and Denmark were drawn from population data for 2005 available from Statistics Denmark (2009).

Data collection: survey

The respondents were asked to rate their frequency of physical activity in their nearest UGS between April and October, as well as their frequency of physical activity in general on a 6-point scale (never, seldom, 1-3 times a month, 1-3 times a week, 4-5 times a week, daily). Respondents were also asked to evaluate the importance of the presence of a range of UGS features in UGS on a 5-point scale (not important at all, not important, neither or, important, very important). For analysis purposes the two most extreme categories were included into their neighbour categories resulting in a 3-point scale (not important, neither or and important). Background factors such as age, gender, education and self perceived health were included in the questionnaire.

To be able to combine the questionnaire data with other data, the addresses of all respondents have been added as anonymised address points in a Geographic Information System (GIS). The questionnaire data was then linked to each address point enabling analyses that utilise both questionnaire data and objective UGS data.

The questionnaire used in this study was inspired by questionnaires used in earlier surveys by Tyrväinen et al. (2007), Nielsen and Hansen (2007), and Grahn and Stigsdotter (2003). The feedback on a preliminary version of the questionnaire sent to a selected group of respondents, who were not part of the sample, was incorporated in the final version of the questionnaire. The survey was approved by the Danish Data Protection Agency.

Table 1. Characteristics of the study sample, compared with the population in Odense and Denmark.

		n	Respondents	Odense	Denmark
	Total	1305	%	%	%
Gender	Female	699	53.6	51.1	50.5
	Male	592	45.4	48.9	49.5
	no answer	14	1.1	0.0	0.0
Age	17 - 29	463	35.5	25.5	19.9
	30 - 39	269	20.6	19.3	19.5
	40 - 49	190	14.6	17.4	18.8
	50 - 59	179	13.7	16.3	18.3
	60 - 69	118	9.0	12.2	13.7
	70 - 81	66	5.1	9.3	9.9
	no answer	20	1.5	0.0	0.0
Education	<10 years	140	10.7	30.8	32.5
	10-12 years	428	32.8	42.1	41.7
	>12 years	676	51.8	23.7	22.7
	no answer	23	1.8	3.4	3.1
type of residence	single family home	322	24.7	31.7	40.7
	multiple family home	154	11.8	22.0	13.7
	apartment	769	58.9	41.2	38.1
	Dorm	25	1.9	2.3	1.2
	Other	35	2.7	2.8	6.3

Collection of data on urban green space

The green space information available in the GIS based green space management information system used by the Municipality of Odense was used as basis for this study. All UGS entrances, derived from the municipal UGS data, and verified during field visits, were added to a new GIS layer. The data on the size of the UGS and available features was linked to each entrance and the distance to each UGS entrance was calculated with ArcGIS

Network Analyst using a network dataset with all roads and trails accessible for pedestrians and cyclists available from The National Survey and Cadastre Agency of Denmark. This method has been shown to be a more precise measure for UGS proximity than using Euclidian distances (Oh & Jeong, 2007; Lee & Moudon, 2008). In total, 53 different UGS were found to be nearest to at least one respondent, and five of these areas lie outside the study area and for that reason there are also five UGS within the study area that are not nearest to any of our respondents.

Inspired by Kaczynski et al. (2008), we rated the 53 nearest UGS for presence or absence of 39 features based on the main categories used in the Environmental Assessment of Public Recreation Spaces (EAPRS) instrument developed by Saelens et al. (2006). The presence of lights along at least one trail was added as a separate category and became feature number 40 as this was found to be an important feature in a study by Giles-Corti et al. (2005). Recording presence or absence of features and counting the number of entrances was done by the lead author visiting each UGS and ticking off present features on a registration form for each area. The features were divided into features that function as primary settings for PA, facilities, and features that could be supportive of PA, amenities. A full list of features is shown in table 2.

Statistical analysis

Multiple logistic regression analysis was used to investigate the association between potential predicting factors and physical activity at least once a week between April and October. A second analysis was performed for physical activity in the nearest UGS at least once a week in the same period. The results are presented as odds ratios (OR) with 95% confidence intervals (CI). Goodness-of-fit of the models was assessed by the Hosmer-Lemeshow test (Hosmer & Lemeshow, 2000), and the tests indicated that the models fit the data adequately. Statistical analyses were performed using PASW version 17.

Table 2. Possible features of UGS, divided in facilities and amenities. Inspired by Saelens et al.(2006) and Kaczynski et al. (2008).

Facilities	**Amenities**
Paved trail	Drinking fountain
Unpaved trail	Picnic area
Walking/cycling route	BBQ/fire place
Open space	Vending
Wooded area	Restroom
Meadow	Shelter or pavilion
Water area	Entertainment venue/stage
Playground or play equipment	Historical or educational feature
Soccer field	Table
Tennis court	Bench
Basketball court	Other seating
Skate area	Landscaping
Pool	Pleasant view outside park
Other sport facilities	Art/sculpture
	Lights along at least one trail
	Trash cans
	Wildlife areas
	Multiple entrances
	Bike rack
	Parking lot
	Sidewalk adjacent
	Roadway through
	Rules/regulations sign
	Maps
	Event postings
	Telephone

RESULTS

PA in general and PA in the nearest UGS

Almost three-quarter (74.3%) of the respondents report to be physically active at least once a week and 45.7% state to be physically active at least once a week in their nearest UGS. Only 43.0% out of the 74.3% that report PA more than once a week is also physically active at least once a week in their

Table 3. Odds ratio for the association of background factors with being physically active at least once a week in general and in the nearest UGS respectively.

Background factors			PA >1/week			PA in NUGS >1/week		
		n	Odds Ratio	95.0% C.I.	Sig.	Odds Ratio	95.0% C.I.	Sig.
Gender	Female	692						
	Male	589	0.83	0.63-1.09	ns	1.20	0.95-1.52	ns
Age	17 - 29	461	1.00		0.00	1.00		ns
	30 - 39	269	0.58	0.39-0.85	ns	0.90	0.65-1.24	ns
	40 - 49	188	0.68	0.43-1.07	0.10	1.08	0.75-1.55	ns
	50 - 59	177	0.43	0.28-0.67	0.00	1.31	0.91-1.89	ns
	60 - 69	117	0.27	0.17-0.43	0.00	0.79	0.51-1.23	ns
	70 - 81	62	0.42	0.22-0-78	0.01	1.12	0.61-2.07	ns
Education	<10 years	137	1.00		0.00	1.00		0.00
	10-12 years	426	1.41	0.91-2.18	ns	1.38	0.90-2.13	ns
	>12 years	675	2.34	1.53-3.57	0.00	1.96	1.30-2.97	0.00
Health	less good	96	1.00		0.00	1.00		0.00
	good	487	1.11	0.67-1.82	ns	1.03	0.63-1.70	ns
	very good	703	2.41	1.45-4.00	0.00	2.00	1.22-3.28	0.01

nearest UGS. However, 28.0% of those respondents that are physically active on a daily basis use their nearest UGS for PA every day, whereas 15.6% never use their nearest UGS for PA.

We studied the association of four background factors, age, gender, health and education, on PA in general and PA in the nearest UGS. The results in table 3 demonstrate that age, health and education have a significant relation with PA in general and health and education have a significant relation with PA in the nearest UGS. The odds ratio for being physically active at least once a week generally decline with increasing age, whereas they increase with increasing health and a longer education. For being physically active in the nearest UGS a similar increase for health and education can be seen. Age does not seem to be associated with being physically active at least once a week in the nearest UGS.

Association between PA in general and the number and total size of UGS in the neighbourhood as well as size, distance and features of the nearest UGS

Table 4 shows that size of, distance to and the number of features of the nearest UGS did not have a significant relation with PA in general at least once a week. Also, the number of UGS within one kilometre and total size of

UGA accessible within one kilometre did not show an association. We furthermore tested (data not shown) for the number and total size of UGS accessible within two and three kilometre, as well as, within 100, 300 and 600 metres, but the results were the same: no significant association. Based on the found association with background factors and PA in the nearest UGS (see table 3), we tried grouping the respondents by age, education and health before including the UGS characteristics in the model, but this did not change the outcome: no significant association.

Table 4. Odds ratio for the association of being physically active at least once a week in general and size, distance to, number of features of the nearest UGS, as well as the number and total amount of UGS within 1km.

Odds ratio for PA >1/week		Single factors				Combined factors				Combined + adjusted for background factors			
		OR	95.0% CI		Sig.	OR	95.0% CI		Sig.	OR	95.0% CI		Sig.
			Lower	upper			Lower	Upper			Lower	upper	
Size of nearest UGS	<1ha	1.00			ns	1.00			ns	1.00			ns
	1-5ha	0.84	0.62	1.14	ns	0.85	0.61	1.19	ns	0.79	0.55	1.14	ns
	5-10ha	1.18	0.79	1.76	ns	1.10	0.67	1.79	ns	1.00	0.59	1.70	ns
	>10ha	0.96	0.55	1.69	ns	1.09	0.49	2.45	ns	1.20	0.50	2.87	ns
Distance to nearest UGS	< 100 m	1.00			ns	1.00			ns	1.00			ns
	100-300m	1.00	0.71	1.41	ns	0.98	0.69	1.38	ns	0.97	0.67	1.41	ns
	> 300m	1.13	0.78	1.64	ns	1.07	0.73	1.57	ns	1.17	0.77	1.78	ns
Number of features in nearest UGS		1.01	0.99	1.03	ns	1.01	0.98	1.04	ns	1.01	0.98	1.05	ns
Number of UGS within 1km		0.99	0.96	1.02	ns	1.00	0.97	1.03	ns	0.99	0.96	1.02	ns
Total amount of UGS within 1km		1.00	1.00	1.00	ns	1.00	1.00	1.00	ns	1.00	1.00	1.00	ns

Association between PA in the nearest UGS and size, distance and features of this UGS

As can be seen in table 5, size and the number of features are significantly associated with being physically active at least once a week in the nearest UGS when these variables are tested as single factors. Distance to the nearest UGS does not display association.

Each additional feature increases the odds of being physically active, as does increasing UGS size. In our study area in particular having UGS between 5 and 10 hectares as the nearest UGS increases the odds of being physically active there. The number of features seems related to the size of the UGS as the association between the number of features and PA disappears when both factors are taken into a combined model. When we adjust the combined model for background factors, only having an UGS between 5 and 10 hectares as the nearest UGS is significantly associated with PA.

Association between PA in the nearest UGS and features present in this UGS

As mentioned earlier, the number of features appears to be related to the size of the UGS and we therefore decided to test the relation between each recorded feature and PA individually to get an impression of which features are important for PA in the nearest UGS. We tested all 40 features and the

Table 5. Odds ratio for the association of being physically active at least once a week in the nearest UGS and size, distance to, number of features of the nearest UGS.

Odds ratio for PA in nearest UGS >1/week		Single factors				Combined factors				Combined + adjusted for background factors			
		OR	95.0% CI		Sig.	OR	95.0% CI		Sig.	OR	95.0% CI		Sig.
			Lower	upper			Lower	upper			Lower	upper	
Size of nearest UGS	<1ha	1.00			0.00	1.00			0.05	1.00			ns
	1-5ha	1.23	0.94	1.61	ns	1.21	0.90	1.62	ns	1.20	0.87	1.64	ns
	5-10ha	1.93	1.37	2.71	0.00	1.78	1.18	2.71	0.01	1.61	1.04	2.49	0.03
	>10ha	1.30	0.79	2.13	ns	1.19	0.67	2.09	ns	1.27	0.70	2.32	ns
Distance to nearest UGS	<100m	1.00			ns	1.00			ns	1.00			ns
	100-300m	0.90	0.67	1.22	ns	0.87	0.64	1.18	ns	0.86	0.63	1.18	ns
	>300m	1.09	0.79	1.51	ns	1.04	0.75	1.45	ns	1.11	0.78	1.57	ns
Number of features in nearest UGS		1.03	1.01	1.05	0.01	1.01	0.98	1.03	ns	1.01	0.99	1.04	ns

presence of the following features has a significant (P<0.05) positive association with PA: a walking and/or cycling route, a wooded area, a water feature (lake, stream), lights along (some) trails, a pleasant view to the outside of the UGS, a bike rack or a parking lot for cars. When all features were divided into facilities and amenities, each additional facility or amenity turns out to be significant too. When we tested a combined model including all significant features at the same time, the significance disappears indicating that the features are mutually dependant. However, each individual factor maintains its significance when included in a model adjusted for background factors. Rather surprisingly, none of the features specifically aimed at PA (various types of sport fields and other sport facilities) seem to increase the odds that an UGS is used for PA.

Preferences for features

In our survey, we asked respondents about importance of a range of features and facilities in UGS near to their homes. The results in table 6 illustrate that many trees, water, and lights are among the most preferred features, while at the same time being among those features that have a significant relation with PA. We did not specifically record the presence of lawns, the presence of a varied plant and animal life, and areas without trails and paths, the other features that are important for the respondents.

Table 6. Importance of different features according to the respondents, in %.

In % of respondents	Not important	Neither or	Important
Many trees	6.5	14.0	79.5
Lakes, streams and canals	11.1	14.7	74.2
Lawns	12.1	13.7	74.2
Lights	13.9	17.0	69.1
Varied plant and animal life	16.2	18.4	65.4
Open areas	11.2	24.7	64.1
Areas without trails and paths	17.2	19.3	63.5
Nice views outside the area	13.6	24.4	62.0
Exercise trails	26.9	24.2	48.9
Flowerbeds	28.1	29.1	42.8
Play equipment	37.9	24.1	37.9
Signposting & information	32.7	34.0	33.4
Many benches and other seating	40.0	27.6	32.3
Toilets	42.9	26.1	31.0
Soccer fields	48.3	28.0	23.8
BBQ and fire places	58.5	21.9	19.6
Fountains	54.7	31.3	14.0

DISCUSSION

We set out this study to investigate if size, distance and features of the nearest UGS were associated with being physically active there. We furthermore wanted to answer if the number and total size of UGS in the neighbourhood as well as size, distance and features of the nearest UGS were related to PA in general.

Association between PA in the nearest UGS and size, distance and features of this UGS

The number of features is of influence, as is size of the UGS. However, the effect of the number of features disappears when entered in a combined model indicating that the number of features is related to size, which seems logical and is supported by earlier finding of Giles-Corti et al. (2005) and Kaczynski et al. (2008). In the study by Giles-Corti et al. (2005), only size had a significant association in the combined model, where as in the study by Kaczynski et al. (2008) only the number of features had a significant association in the combined model. Giles-Corti et al. (2005) found that for UGS of similar size, an increasing number of features is associated with PA. In the current study, the association of size is only significant for the four UGS between 5-10 hectares compared to the reference group of areas smaller than one hectare. A significant association for the two UGS larger than 10 hectares was not found. This is most likely due to the location and character of the areas; the two largest UGS, both woodlands, are relatively remote whereas the other four UGS have a very central location.

When studying the association of the different features in more detail, we found, similar to Kaczynski et al. (2008), that a wooded area being present had a significant effect. We did not find the strong association between paved or unpaved trails, as found by Kaczynski et al. (2008), but instead we found a relation between the presence of a walking and/or cycling route that could be both paved and unpaved. We furthermore found positive associations for the presence of a water feature (lake, stream), lights along (some) trails, a pleasant view to the outside of the UGS, a bike rack or a parking lot. There is a clear similarity between the preferred features (table 6) and the features significantly associated with PA. This indicates that it might be useful to expand the features recorded in the field with presence of lawns and areas without paths or trails. Likewise, in a next survey respondents could be asked to rate the importance of all features recorded in the field.

In contrast to Giles-Corti et al. (2005), distance had no association in this study. This might be explained by the high availability of UGS in our study area; only 1.8% of respondents had to go more than 600 metres to their nearest UGS, and 68.9% had their nearest UGS within 300 metres. On the other hand, also Kaczynski et al. (2008; 2009) did not find a relation between the distance to UGS and PA in their study.

Association between PA in general and the number and total size of UGS in the neighbourhood as well as size, distance and features of the nearest UGS

The results show no significant associations for any of the tested independent UGS variables. This is in line with results of the studies by Maas et al. (2008) and Hillsdon et al. (2006), while it is contradicted by results of the study by Kaczynski et al. (2009). This difference might be explained by how the distance to the nearest UGS is measured. Kaczynski et al. (2009) used the average Euclidian distance from the respondents' home to the centre of each park in their calculations, which is a rather poor measure for distance (Oh & Jeong, 2007; Lee & Moudon, 2008). Our study, as well as the study by Hillsdon et al. (2006), calculated distances between the home of each respondent and the nearest entrance of the nearest UGS measured using a network of roads and trails accessible for pedestrians, a more precise measure (Oh & Jeong, 2007; Lee & Moudon, 2008).

Discussion of methodology

From a methodological point of view the main strength of the current study lies in the fact that all data has precise geographic references and that distance to and size of UGS could be calculated very precise. Furthermore, the relatively large number of respondents can be seen as strength.

The EAPRS tool used to describe UGS features is tested and found reliable (Saelens et al., 2006; Kaczynski et al. 2008) and we consciously chose not to use the quality assessments included in the EAPRS tool as these assessments were reported to be less reliable (Saelens et al., 2006). The EAPRS categories are in many ways similar to categories used by Hillsdon et al. (2006) and Giles-Corti et al. (2005) to describe the features of UGS.

The possibility of combining questionnaire data with GIS data is a strength of this paper (Millington et al. 2009), but there is also a risk of misinterpretation as we do not know for sure that the UGS that is objectively the nearest also is the one that respondents refer to when mentioning their nearest area. Nor do we know if all UGS that are mentioned in the municipal GIS, are recognised as such by the respondents. Especially for the many small UGS, it seems doubtful that they were always recognised as usable UGS, even though we only included UGS in our analyses that had at least one entrance and could be visited.

Another possible limitation of this study could be the relatively high non-response rate (47.8%) and, for that reason, non-response analyses were carried out. A relatively high non-response means that there is a risk that our respondents do not fully represent the population as those actually using UGS might be more inclined to return a questionnaire on this topic. The analyses showed a slight overrepresentation of women among our respondents, 53.6%, compared to 49.2% among the sample. It furthermore showed a slight underrepresentation of persons between 17-29 years old; 35.8% among the respondents versus 39.7% among the sample. But these differences are not significant (data not shown) and therefore not likely to have had a large impact on our results.

We used self-reported PA as measure for PA, which was most likely interpreted by the respondents as more intensive recreational PA. While self-reported PA tends to be overestimated compared to the actual level of PA, several studies report a significant correlation between the two measures for PA (e.g. Harris et al., 2009; Jacobi et al., 2009).

Finally, our study was not set up to be representative, which is important to keep in mind when generalising from the results. We did compare age, gender and education for our respondents, the population in the city of Odense and the population of Denmark in general using data from Statistics Denmark to get an impression of how different our respondents were (see table 1). As expected, we found that our respondents are not representative for the Danish population, typically being younger and higher educated than the average population. However, a similar population can probably be found in the central parts of larger cities with a university or other higher educational institutions.

Future research

This study had an explorative character to determine which factors were relevant to include in a more representative study. The study area has a good supply of UGS, even though most UGS are small, and only 1.8% of the respondents have to go further than 600 metres to their nearest UGS. This might be the main explanation for the fact that we did not find an association between the amount of UGS and PA in general. On the other hand, other European studies (Hillsdon et al. 2006, Maas et al. 2008) seem to come to similar conclusions. Based on the result from this study, a more representative study area with more variation in availability of UGS can be recommended. Studying the association between UGS and PA for other user groups than in our current study, such as children, teenagers and people with another ethnic background seems another obvious direction for future research. Finally, longitudinal or intervention studies are needed to reveal causal relations.

CONCLUSIONS AND IMPLICATIONS FOR PRACTICE

European cities typically have a different type of city structure, and recommendations for North American or Australian cities are not necessarily valid for European cities. The result from this study, as well as a few other European studies, seem to indicate that the total amount of UGS, as well as the distance to the nearest UGS are less important when trying to stimulate PA. The size and features of an UGS do seem to influence how attractive this UGS is for PA. Presence of a larger UGS (>5ha) with a wooded area, a water feature, a walking and/or cycling route, lights along (some) trails, a pleasant view to the outside of the UGS, a bike rack or a parking lot is likely to promote PA in that UGS. There is no indication in our study that adding more features specifically aimed at PA, such as exercise pavilions or sports fields, will increase the use of UGS for PA.

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PAPER IV

TYPICAL USERS OF URBAN GREEN SPACE: A LATENT CLASS MODEL

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TYPICAL USERS OF URBAN GREEN SPACE: A LATENT CLASS MODEL

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ABSTRACT

Using a Latent Class Analysis (LCA) and a sample of 1305 Danish adults from the City of Odense we examined the use of urban green space (UGS). The LCA resulted in a model with five clusters that can be described phenomenologically and demonstrate differences in their frequency of use, the activities, time spent, preferences for features, and constraints for visiting more often. The percentage of respondents that is part of each cluster differs for each neighbourhood in the study area indicating that green space managers can use the results of this study to develop UGS in the different neighbourhoods.

Keywords
City planning, Green space management, Segmentation, Latent Class Analysis, Green space preferences.

INTRODUCTION

The average camper who doesn't exist is the title of a famous paper by Elwood Shafer (1969). In his paper Shafer argues for a more differentiated approach to leisure studies, as campers differ from campground to campground and from month to month. Something similar can be said for users of urban green space (UGS) and many studies report significant differences in the use of UGS depending on individual factors such as age, education, gender and ethnicity (e.g. Galloway, 2002; Giles-Corti, Broomhall, Knuiman, Collins, Douglas, Ng, Lange & Donovan, 2005; Payne, Mowen & Orsega-Smith, 2002; Tinsley, Tinsley & Croskeys, 2002; Sasidharan, Willits & Godbey , 2005).

In the past five years the use of urban green space has received renewed attention and this is likely to continue as the majority of the world population now lives in cities, and with the percentage of the population living in urban areas expected to increase further (UNFPA, 2007). Urban green space is important for the health and well-being of the urban population and the amount of green space close to where people live is positively associated with their self-perceived health (Maas et al., 2006) and reduced mortality (Mitchell & Popham, 2008). Residents that have green space close to home are more likely to use it regularly (Coles & Busey, 2000; Grahn & Stigsdotter 2003; Nielsen & Hansen, 2007), which in turn seems to promote various aspects of health. Green space is among other suggested to promote public health by serving as a resource for physical activity (Björk et al., 2008), and by reducing stress levels (Grahn & Stigsdotter, 2003; Nielsen & Hansen, 2007; Ulrich, 2006).

The presence of facilities and possibility for activities are also thought to have an influence on the use of urban green space (Bedimo-Rung, Mowen & Cohen, 2005; Giles-Corti, Broomhall, Knuiman, Collins, Douglas, Ng, Lange & Donovan, 2005; Van Herzele & Wiedemann, 2003). Furthermore, Kaczynski, Potwarka and Saelens (2008) found an association between the number of features present and physical activity in and urban green space. Various studies have found differences in preferences for different features of green space among different groups of user (Gobster, 2002; Kemperman & Timmermans, 2006a; 2006b; Payne, Mowen & Orsega-Smith, 2002; Sasidharan, Willits & Godbey , 2005; Tinsley, Tinsley & Croskeys 2002). Green space managers and planners would like to provide green space that satisfies the needs and wishes from urban residents, and for that reason, knowing more about the wishes and demands from different types if users would be helpful to them. However, as users are so different, knowing what the average user wants only has limited value, and adapting green space to satisfy the wishes of each individual user is impossible. To solve this classic marketing problem, most commercial companies have developed marketing strategies based on segmentation of the customers into more homogenous subgroups. Also within leisure and tourism research the use of segmentation models to create subgroups is becoming more common (e.g. Dolnicar, 2004; Dolnicar & Grün, 2008; Kemperman & Timmermans, 2006a; 2006b; 2008; Pennington-Gray, Fridgen & Stynes, 2003; Pinquart & Schindler, 2009).

There are many different types of segmentation methods that can be divided into two main types: commonsense, a priori; and data driven, post-hoc (Dolnicar, 2004). A post-hoc data driven segmentation is preferred by many researchers as it is based directly on empiric data and not biased by assumptions that could be wrong. However, clusters derived directly from data can also be hard to understand, which increases the risk of misinterpretations of the results (Dolnicar & Grün, 2008). For that reason we feel that it is important that the data driven segments can also be described phenomenologically, and do not conflict with commonsense a priori expectations.

Creating a segmentation of users of green space will be especially useful to green space planners or managers if the different types of users can be located spatially, indicating which type of use of green space could be expected or desired where.

The aim of this study is to identify typical users for urban green space in a Danish city. The main research questions are:

- Which segments of users can be identified from the data and be described phenomenologically?
- What type of use do the different segments of users display?
- Which demands and preferences for urban green space do the different segments of users have?

METHODS

To investigate the use of UGS and the different segments of users in more detail we have focused on generating data with a high level of detail for a relatively small study area in one city. We used a postal survey with randomly selected inhabitants to collect data on self reported use of urban green space.

Definitions

Urban green space (UGS) is defined as all publicly owned and publicly accessible open space with a high degree of cover by vegetation, e.g. parks, woodlands, nature areas and other green space. It can have a designed or cultural character as well as a more natural character. Only areas that can be entered by users are included.

Use of urban green space (use of UGS) is defined broadly as any sort of visit to an urban green space, without looking at the duration of the stay, the reason for visiting or the activity done while visiting; e.g. passing through on the way to a destination is also counted as use.

Study area

The City of Odense, centrally located in Denmark, was selected as study area because of its image of being a “green and active city” (City of Odense, 2008). The Municipality of Odense has a population of 187 929 as of January 2009 (Statistics Denmark, 2009) and it is the third largest city of Denmark. The central part of the city was selected as study area for its large variation in both UGS and types of residents. The UGS in this part of the city range from historic gardens and parks with a very high maintenance level, to neighbourhood parks, to larger recreational parks, including one of the city’s largest woodland areas. The large variation was chosen intentionally to increase the possibility to generalise the result from this study to other Danish cities. A circle with a two kilometre radius with the main railway station as central point was drawn as border of the study area (see figure 1). It is a relatively green area with a total of 53 UGS, but most UGS are small. Only two of these UGS are more than ten hectares in size, four are between five and ten hectares, 15 are between one and five hectares and the remaining 32 UGS are less than one hectare. Seven distinct neighbourhoods can be identified in the study area: Hunderup, Kragsbjerg, Skt Jørgens Gade, Centrum, Vesterbro, Åløkke and Skibhus. Åløkke and Hunderup are characterised by older villas with relatively large gardens, and are traditionally seen as richer areas within the city. Skibhus is an older working class area with mixed housing including detached, semi-detached as well as apartment blocks that is undergoing changes; many well-educated young families with children have moved into the neighbourhood in the past five years. Centrum is, as the name suggests, the true city centre with many shops and older apartment buildings. Vesterbro used to be a working class neighbourhood with many small apartments, but the area has undergone a transformation and is now considered to be a trendy part of the city by young people. Kragsbjerg and Skt Jørgens Gade have also experienced some change the past years, but are still mainly working class neighbourhoods with apartment buildings from the middle of the 20th century mixed with other types of homes.

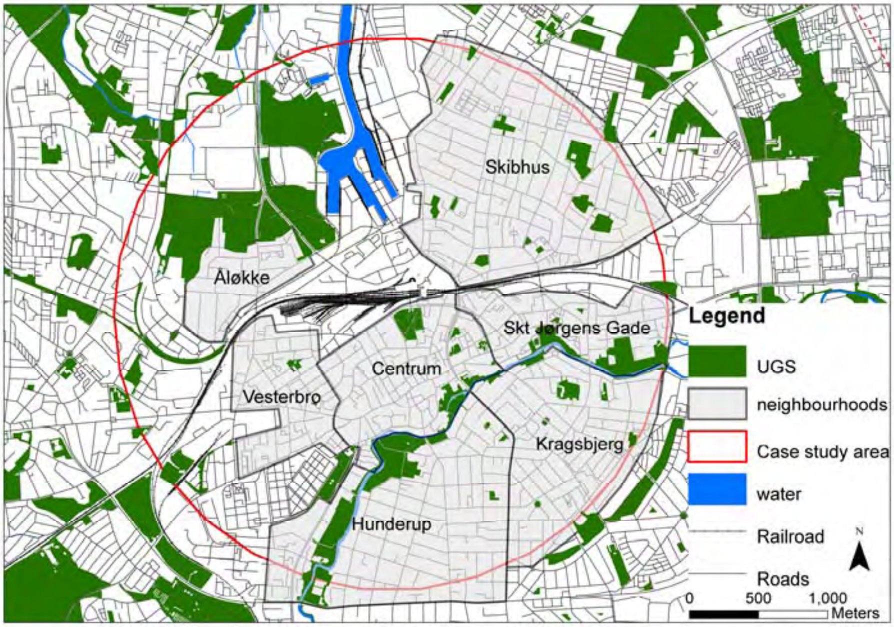

Figure 1. Study area with all accessible urban green spaces and seven neighbourhoods.

Study sample

The Municipal Statistics Department in Odense randomly selected 2 500 residents aged 18-80 that received an 18-page postal questionnaire in October 2005. In total, 1 305 persons (52.2%) returned the questionnaire after we had sent two reminders. About 35 000 inhabitants between 18-80 years old live in the study area and a more detailed description of the respondents compared with the general population of Odense and Denmark can be seen in table 1. Numbers for Odense and Denmark were drawn from population data for 2005 available from Statistics Denmark (2009). Our respondents are not representative for the Danish population with 36.6% of the respondents being between 17 and 29 years old, versus 25.5% in Odense, versus 19.9% in Denmark. Furthermore, our respondents clearly have a longer education than average; 51.8% of our respondents had more than 12 years of education, compared to 23.7% and 22.7% for Odense and Denmark respectively. A similar population can probably be found in central parts of larger cities with a university or other higher educational institutions.

Table 1. Characteristics of the study sample, compared with the population in Odense and Denmark.

		n	Respondents	Odense	Denmark
	Total	1305	%	%	%
Gender	Female	694	53.2	51.1	50.5
	Male	611	46.8	48.9	49.5
Age	17 - 29	477	36.6	25.5	19.9
	30 - 39	267	20.5	19.3	19.5
	40 - 49	189	14.5	17.4	18.8
	50 - 59	187	14.3	16.3	18.3
	60 - 69	118	9.0	12.2	13.7
	70 - 81	67	5.1	9.3	9.9
Education	<10 years	140	10.7	30.8	32.5
	10-12 years	428	32.8	42.1	41.7
	>12 years	676	51.8	23.7	22.7
	No answer	23	1.8	3.4	3.1
type of residence	Detached home	322	24.7	31.7	40.7
	Semi-detached home	154	11.8	22.0	13.7
	Apartment	769	58.9	41.2	38.1
	Student house	25	1.9	2.3	1.2
	Other	35	2.7	2.8	6.3

Data collection

In our survey, respondents were asked to rate their frequency of use of their nearest UGS, between April and October, on a 6-point scale (never, seldom, 1-3 times a month, 1-3 times a week, 4-5 times a week, daily. The respondents were furthermore asked to estimate the distance to their nearest UGS as well as their most used UGS on an eight point scale (<100m, 100-300m, 300-600m, 600m-1km, 1-2km, 2-5km, 5-10km and >10km). They were asked about the activities done when visiting and possible constraints for visiting more often, for the nearest UGS. Respondents were also asked to evaluate the importance of the presence of a range of UGS features in UGS on a 5-point scale (not important at all, not important, neither or, important, very important). A question presenting a series of statements on UGS was included as well and respondent could answer on a 5-point scale (disagree, partly disagree, neither or, partly agree, agree). The respondents evaluated their own current health status on a 5 point scale (poor, less good, good, very good and excellent). Finally, background factors such as age, gender, level of education, income, type of residence and number of children were included in the questionnaire.

The survey used in this study was inspired by earlier surveys by Tyrväinen, Mäkinen and Schipperijn (2007), Nielsen and Hansen (2007), and Grahn and Stigsdotter (2003). A pilot test was performed on a selected group of respondents, who were not part of the sample, and their feedback was incorporated in the final version of the survey before it was distributed. The survey was approved by the Danish Data Protection Agency.

The addresses of all respondents were added as anonymised address points in a Geographic Information System (GIS) which enables us to locate the different types of users spatially. Furthermore, all UGS entrances were added to a new GIS layer in order to calculate the distance from each respondent to each UGS entrance with help of ArcGIS Network Analyst using a network dataset with all roads and trails accessible for pedestrians and cyclists available from The National Survey and Cadastre Agency of Denmark. Using network distances is seen as a more precise measure for UGS proximity than using Euclidian distances (Lee & Moudon, 2008; Oh & Jeong, 2007).

Statistical analysis

Clustering respondents (cases) can be done in various ways and we have chosen to use Latent Class Analysis (LCA) as our data does not comply with the assumptions needed for parametric clustering methods; linear relationships, normal distribution or homogeneity. LCA has the additional advantage that a mixture of nominal, ordinal, continuous and count data can be used in the same model. With LCA related cases (latent classes) of respondents are identified using combinations of observed and unobserved (latent) data. The cluster algorithm in an LCA differs from traditional cluster analysis algorithms, which groups cases near each other by some definition of distance. Instead, the latent class approach defines one cluster per latent class, using model-based probabilities to classify cases. See Hagenaars and McCutcheon (2002) or Magidson and Vermunt (2004) for more details on LCA.

A data driven segmentation can be based on different types of data, and three main types of data can be distinguished: psychographic data (preferences, values, attitudes), behavioural data and socio-demographic data. These types of data are often used in various combinations in segmentation studies.

The socio-demographic variables known to influence the use of UGS in the study area, age, gender, the level of education, and having children under the age of six, were included in the model (Schipperijn, Stigsdotter, Randrup & Troelsen, in press, Paper II). Furthermore, a series of possible activities (running, cycling, dog-walking, sunbathing, BBQ or eating, sport or play, relaxing or sleeping and a tour with friends or family) were included as behavioural variables. Gender, having children under the age of six, and all activities were entered as binary variables, education was a nominal variable with three possibilities (1, < 10 years education; 2, 10-12 years education; 3, > 12 years education), and age was entered as a continuous variable. Going for a walk in the nearest UGS was initially included as an activity, but later removed from the model as it turned out that this was done by nearly all respondents.

RESULTS

Latent Class Analysis

We conducted an initial LCA to narrow down the number of clusters that would need to be explored more fully. One to ten cluster solutions were generated and the Bayesian Information Criterion (BIC) and Log-Likelihood (LL) indicated that a five and six cluster model were worth exploring further as the values for both BIC and LL were very close to each other for these two models. However, one of the clusters in the six cluster model was small, about 4.5% of the respondents. Based on the bivariate residuals diagnostics, covariances between various variables were also estimated for each cluster. With adding each additional covariance to the model, the model was gradually improved and in its final form, a five cluster solution turned out to be the best model. The robustness of the five cluster model was tested by running 500 repetitions of the model, each with a random starting point, and all runs resulted in the same model. A total of 1 229 respondents could successfully be assigned to a cluster, for the remaining 76 respondents data for one or more variables was missing, excluding them from the analysis.

The results of the five-cluster model are summarised in table 2, which shows that the chances of respondents being classified correct within each cluster vary from 81.3% for cluster 2, to 95.0% for cluster 5. The chances of miss-classification are the largest between cluster 1 and 4, and cluster 2 and 3. The size of the clusters varies from 33.2% of the respondents for cluster 1, to 12.9% for cluster 5.

Table 2. Five clusters of users of UGS. In % of respondents, excluding age in years, and education on a 3 point scale (1, < 10 years education; 2, 10-12 years education; 3, > 12 years education)

	Cluster				
	1	2	3	4	5
n	408	285	191	186	159
% of total	33.2	23.2	15.5	15.1	12.9
Average age	49.7	27.3	21.8	59.8	33.3
% male	46.8	50.5	35.1	55.4	46.5
% with children < 6 years old	1.0	0.7	0.0	0.0	96.2
Average education level	2.8	2.7	2.0	1.5	2.6
% running in UGS	23.0	46.3	30.9	0.5	25.8
% cycling in UGS	39.0	34.4	28.3	16.1	23.9
% dog-walking in UGS	13.0	2.1	6.8	18.3	4.4
% sunbathing in UGS	7.1	25.6	42.4	3.2	1.9
% BBQ in UGS	5.6	14.4	17.8	0.0	5.0
% sport and play in UGS	12.3	14.4	17.8	4.3	55.3
% relax or sleep in UGS	8.8	22.5	38.2	5.9	8.8
% tour with friends or family in UGS	21.1	28.4	49.2	3.8	49.1
Chance of being part of cluster 1	90.4	7.5	1.1	14.5	2.4
Chance of being part of cluster 2	1.4	81.3	13.9	0.0	2.6
Chance of being part of cluster 3	0.0	8.5	84.4	0.0	0.0
Chance of being part of cluster 4	5.9	0.5	0.3	85.4	0.0
Chance of being part of cluster 5	2.3	2.3	0.4	0.1	95.0

Typical users of UGS

As can be observed in table 2, three socio-demographic characteristics can be used to describe the main difference between the five clusters: age, education and having children under the age of six. In table 3, the variation between the clusters for some more background variables can be seen. The first cluster consists mainly of middle aged (50 years old on average), well educated respondents that rarely have young children and the majority (55.9%) lives in a house with a garden. The second cluster is made up by young, on average 27 years of age, and well educated respondents, typically without children, and predominantly living in an apartment. The third cluster consists of even younger respondents (22 years old on average), the majority (64.9%) is female, 89.5% uses their bicycle for daily transport, and 70.2% are still studying, which explains their lower level of education. Cluster number four is the cluster with the highest average age (60 years old), a relatively low level of education, a high percentage (58.1%) of respondents that do not work, 22% state that they are in less good health, and only half (49.5%) of them use their bicycle for daily transport over 300 metres. The last and fifth cluster consists primarily of respondents with young children (96.2%) with an average age of 33 years old, and just over half (54.7%) of them live in apartments.

Table 3. Background factors for the five clusters of users of UGS. In % of respondents in each cluster.

		Cluster					
		1	2	3	4	5	
		% of each cluster					*n*
House or apartment	House	55.9	13.0	16.2	43.5	45.3	449
	Apartment	44.1	87.0	83.8	56.5	54.7	780
Own garden	Yes	56.4	10.9	15.2	46.8	49.1	455
Civil status	In relationship	64.9	66.5	55.0	60.8	89.9	813
Occupation	Employed	77.9	52.3	23.0	40.9	67.9	695
	Not employed	19.1	7.4	6.8	58.1	14.5	243
	Student	2.9	40.4	70.2	1.1	17.6	291
Health in 3 classes	Less good	7.6	1.1	5.2	22.0	3.8	91
	Good	38.4	37.2	28.3	44.1	38.0	458
	Very good	53.9	61.8	66.5	33.9	58.2	677
Means of daily transport for distances over 300m (multiple answers possible)	Car	50.0	33.7	26.2	48.4	61.0	537
	Walking	52.2	54.4	52.9	51.6	54.7	652
	Cycling	79.7	89.1	89.5	49.5	78.6	967
	Train	9.1	13.0	11.0	3.8	8.8	116
	Bus	11.8	11.9	18.3	17.7	12.6	170

Frequency of use per user type

The five clusters differ in their patterns of use of the nearest UGS as can been seen in table 4. Within cluster 4 the variation is the largest with both a relatively high percentage of non-regular users (26.3%), as well as 15.1% daily users. The same pattern can been observed for this cluster for the time spent per week in the nearest UGS; 12.4% spent no time at all in their nearest UGS, while at the same time 18.8% spent at least three hours a week there. When looking at the daily time spent in any green space (including private gardens), it becomes clear that all five clusters increase their total time spent in green space during weekends and especially holidays. There are however large differences between the clusters. Cluster 4 spends the most time on weekdays, but the increase for weekends and holidays is not very strong, whereas cluster 1 and 5 display a strong increase in the time spent in green space during weekends and holidays, compared to weekdays. The younger respondents in clusters 2 and 3 spent the least amount of time in green space.

Table 4. Frequency of use and time spent in UGS for the five clusters of users of UGS. In % of respondents in each cluster.

		Cluster					
		1	2	3	4	5	
		% of each cluster					*n*
Frequency of visits to the nearest UGS	Rarely or never	15.7	20.4	23.0	26.3	11.9	234
	1-3 times a month	25.0	28.8	28.3	21.5	30.2	326
	1-3 times a week	33.3	37.9	33.0	21.5	40.9	412
	4-5 times a week	13.2	7.7	10.5	10.2	10.7	132
	Daily	12.3	4.9	4.7	15.1	6.3	111
Time per week spent in the nearest UGS	None	4.4	5.3	6.8	12.4	1.9	72
	< 1hr weekly	43.4	48.8	44.0	40.9	41.5	542
	1-3 hrs weekly	39.5	34.0	33.0	23.1	40.9	429
	> 3hrs weekly	10.5	11.9	16.2	18.8	15.1	24
Time per day on weekdays spent in green environments	< 30 min daily	24.3	51.6	49.2	21.0	23.9	417
	½-2 hrs daily	47.8	39.6	38.7	32.8	57.9	535
	> 2 hrs daily	27.0	8.1	11.0	38.2	17.6	253
Time per day on weekends spent in green environments	< 30 min daily	10.0	27.7	27.7	18.3	6.3	217
	½-2 hrs daily	33.8	41.8	33.0	22.0	38.4	422
	> 2 hrs daily	54.9	29.5	38.7	52.2	55.3	567
Time per day on holidays spent in green environments	< 30 min daily	8.1	20.4	18.3	15.6	5.0	163
	½-2 hrs daily	21.1	30.2	27.2	16.1	29.6	423
	> 2 hrs daily	68.9	48.4	53.9	57.0	65.4	732

Distance to the nearest UGS

The objectively measured distance to the nearest UGS shows that accessibility in general is good (see table 5), only 23 respondents (1.9%) have to go more than 600 metres to their nearest UGS, and no respondent has to go more than 900 metres (data not shown). However, there are small differences in accessibility between the clusters with respondents in cluster 1 and 5 typically having to go a bit further than respondents in the other clusters. Looking at the self-evaluated distance to the nearest UGS it seems that relatively many of the younger respondents in cluster 2 and 3 estimate their nearest UGS to be further away than it is in reality. For the self estimated distance to the most used UGS cluster 2 and 3 are even more distinctively different; respectively 47.4 % and 44.0% of cluster 2 and 3 state that their most used UGS is more than 600 metres from their home, compared to 37.7%, 28.5% and 31.4% for respectively clusters 1, 4 and 5. For roughly half (52.2% and 49.4%) of the respondents in cluster 2 and 3, their nearest UGS is not their most used UGS.

Table 5. Distance to UGS for the five clusters of users of UGS. In % of respondents in each cluster.

		Cluster					
		1	2	3	4	5	
		% of each cluster					*n*
Network distance to nearest UGS	< 100 metres	17.6	20.4	17.8	18.3	15.1	222
	100-300 metres	49.0	53.7	55.0	50.0	48.4	628
	300-600 metres	29.2	26.0	26.7	31.2	34.0	356
	> 600 metres	4.2	0.0	0.5	0.5	2.5	23
Self evaluated distance to nearest UGS	< 100 metres	29.2	29.5	33.5	31.7	37.7	386
	100 - 300 metres	35.3	30.5	22.5	34.9	32.7	391
	300 - 600 metres	25.2	23.5	26.2	19.4	18.2	285
	> 600 metres	10.0	16.1	17.3	10.8	10.7	157
Self evaluated distance to most used UGS	< 100 metres	16.9	15.1	18.3	17.7	20.1	212
	100 - 300 metres	19.4	17.2	11.5	22.6	28.3	237
	300 - 600 metres	21.6	15.8	18.3	16.1	17.6	226
	> 600 metres	37.7	47.4	44.0	28.5	31.4	476
Distance to most used UGS is longer than to nearest UGS		44.9	52.2	49.4	40.4	40.0	529

Preferences for UGS characteristics

Virtually all (at least 93.2%) respondents find it important that UGS is kept clean from trash (table 6), and most respondents (at least 75.3%) agree that UGS to be an experience in it self, and at least 79.8% considers UGS to be a good place to think and relax. For most of the other statements we presented to the respondents, larger differences can be observed between the five clusters. A good UGS according to respondents in cluster 1 is a place to enjoy nature and important for the quality of life. It should have many trees, water elements, a varied plant life and it should be peaceful and quiet. For respondents in cluster 2, a good UGS plays an important role for physical activity and being with friends. There should be lights, lawns and exercise trails and views on water are important desired qualities too. Respondents in cluster 3 rarely use UGS alone, being there together with friends and observing social life is important, but UGS are also a good place to relax. BBQ or fire places, and lights and lawns are important features for many respondents in this cluster. UGS can feel unsafe to visit alone for 35.5% of the respondents in cluster 4, and lights are important to many, as are flowerbeds, benches, toilets and signs. Enjoying nature and landscapes is done preferably in an UGS with many trees, lawns and a varied plant and animal life. Play equipment is the most desired quality of an UGS for the parents of young children in cluster 5. UGS are to be used together with the rest of the family and lawns, many trees and soccer fields are other preferred features of UGS.

Table 6. Opinions about UGS characteristics for the five clusters of users of UGS. In % of respondents in each cluster.

	Cluster					
	1	2	3	4	5	
	% of each cluster that agrees, or partly agrees					*n*
UGS are an experience in its self	95.8	82.7	75.3	88.4	89.9	1063
UGS are a good place to relax and think	88.7	87.4	82.2	79.8	88.7	1047
UGS are important for my quality of life	87.3	71.6	67.4	66.7	82.9	931
UGS as part of everyday life	75.1	63.9	50.8	64.8	68.4	806
UGS are a good place for physical activity	71.6	77.9	62.8	46.2	74.8	831
UGS are a place for reflection and memories	65.4	58.9	55.5	46.9	50.9	698
UGS are a place to be with friends and family	65.2	75.1	80.1	61.2	89.3	879
UGS are to keep in shape	49.3	56.5	44.0	27.4	41.7	549
UGS are to be used alone	21.7	15.1	9.5	22.0	7.6	198
UGS are unsafe to visit alone	18.7	22.6	31.1	35.5	20.3	292

Table 6 continued. Opinions about UGS characteristics for the five clusters of users of UGS. In % of respondents in each cluster.

	% of each cluster that finds it important or very important					*n*
UGS that is kept clean	94.8	97.2	93.2	95.3	97.5	1153
UGS with many trees	89.0	72.2	72.2	73.7	84.1	953
UGS with lakes, streams and canals	81.1	71.5	71.8	65.4	75.0	885
UGS with varied plant and animal life	78.1	54.2	54.1	71.5	63.0	766
UGS with areas without paths or trails	66.3	60.4	65.1	60.5	67.5	756
UGS with lawns	65.7	79.6	83.1	71.5	81.4	886
UGS with good views	64.9	59.2	62.4	67.7	59.0	742
UGS with open areas	64.3	64.2	62.6	63.6	69.4	766
UGS with lights	59.9	76.5	74.7	77.7	65.8	827
UGS with flowerbeds	45.9	38.0	39.6	57.4	35.4	513
UGS with exercise trails	45.8	64.6	52.9	26.6	47.1	578
UGS with play equipment	38.1	23.0	24.9	36.5	85.4	453
UGS with clear signposting	34.5	27.0	25.7	55.4	27.7	387
UGS with many benches and seating	33.4	22.7	29.4	50.0	33.3	385
UGS with toilets	28.3	26.8	25.3	55.4	22.8	363
UGS with soccer fields	19.0	29.0	25.5	18.2	33.8	285
UGS with fountains	14.5	12.2	15.5	21.2	9.0	166
UGS with bbq and fire places	13.4	23.2	37.7	8.4	17.5	225
	% of each cluster that would like to find each quality					*n*
Enjoy nature and landscape	58.8	49.8	46.6	45.2	41.5	621
View/access to water	53.4	50.9	56.0	33.3	43.4	601
Peaceful and quiet	53.2	46.7	47.6	40.3	35.2	572
Enjoy flowers and plants	52.7	43.2	42.9	39.8	36.5	552
Beautiful park	46.6	44.2	41.4	33.3	27.7	501
Good possibilities for children's play	34.6	23.5	18.8	15.1	89.3	414
Observe social live	27.0	34.4	41.4	16.1	25.8	358
Place for sport and exercise	21.1	35.4	27.2	4.3	27.0	290

Constraints for visiting

Table 7 demonstrates that lack of time is the main constraint for using UGS more, but respondents in cluster 4 find it clearly less of a problem than the respondents in the other clusters. The younger respondents in cluster 2 and 3 see too many other people as problematic, and the respondents in cluster 5 lack possibilities for desired activities. Also a fear of violence or UGS being too dark is seen as problematic by relatively many respondents, in all clusters. UGS being too quiet, poorly designed or poorly accessible do not seem to be constraints for more frequent visits for many.

Table 7. Constraints for visiting UGS more often for the five clusters of users of UGS. In % of respondents in each cluster.

	Cluster					
	1	2	3	4	5	
	% of each cluster that sees it as a constraint for visiting more often					*n*
Lack of time	58.8	64.2	68.6	39.2	60.4	723
Too many people	19.4	29.1	23.0	9.7	13.8	246
Too dark/afraid of violence	16.9	21.1	17.3	12.4	10.7	202
Too far away	9.8	14.7	13.1	11.3	11.9	147
Poor design	6.6	8.1	6.8	2.7	8.8	82
Lack of possibility for desired activities	6.6	8.4	3.7	6.5	25.8	111
Too quiet	4.2	3.5	3.7	2.7	1.9	42
Poorly accessible	3.2	3.2	3.1	4.3	0.6	37

Spatial location of user types

We studied the distribution of the clusters over the seven neighbourhoods in the study area (see figure 1) and table 8 shows that there are differences between the neighbourhoods. Hunderup and Åløkke clearly have a high percentage of respondents belonging to cluster 1, and Skt Jørgens Gade has a relatively high percentage of respondents in cluster 3, while cluster 5 is underrepresented in that neighbourhood. Åløkke seems to have few young couples that make up cluster 2, and Hunderup doesn’t count many respondents belonging to cluster 4. The larger neighbourhoods, Skibhus and Kragsbjerg, reveal a distribution over the clusters that is relatively similar to the average for the whole study area, but also for these neighbourhoods differences can be seen. Kragsbjerg has a relatively high number of respondents in cluster 2, and many respondents belonging to cluster 4 live in Skibhus.

Table 8. Allocation of the five clusters of users of UGS in different neighbourhoods. In % of respondents in each neighbourhood.

	1	2	3	4	5	
	% of population in each neighbourhood					*n*
Hunderup	47.1	20.2	13.5	6.7	12.5	104
Kragsbjerg	31.0	28.4	17.2	11.8	11.5	348
Skt Jørgens Gade	30.9	22.2	19.8	17.3	9.9	81
Centrum	29.4	24.8	14.4	19.0	12.4	153
Vesterbro	25.7	27.8	16.7	16.7	13.2	144
Åløkke	45.3	11.3	17.0	11.3	15.1	53
Skibhus	32.8	20.1	14.3	17.4	15.4	293
Average	33.2	23.2	15.5	15.1	12.9	1229

DISCUSSION

Different types of users

The results of this study clearly show that there are large differences between the five clusters.

The well-educated families that make up cluster 1 often walk and cycle in their nearest UGS, and they occasionally participate in other activities too. They seem to visit UGS quite often, relatively many visit on a daily basis, but for rather short visits. Many of them have a garden, which probably explains the high total time spent in green environments (including gardens) on weekends and holidays.

The young couples, often well-educated and usually without children, in cluster 2 participate in many different activities in UGS, including the more active ones, typically at least once a week. This group of people are the most active runners, and cycling in UGS is common too, probably as part of daily transport for many as cycling is their main means of transportation. They are often willing to go further than their nearest UGS. Having a garden is uncommon for this group, reducing their total time spent in green environments. This group spends the least amount of total time in a green environment, especially on weekdays.

The youngest people in our survey, most of them students, form cluster 3 and they have a predominantly social use of UGS. Meeting with friends to relax, lie in the sun and eat, or drink are common activities. Visiting the right place, with the right people seems important, and this group is therefore willing to go a bit further to find a UGS they like. And for some also a more active use, e.g. running or team sports, is common too. The total time spend in green environments is relatively low, in particular on weekdays.

Most seniors are part of cluster 4, as are most people with a poor health or a shorter education. Many persons in this cluster do not work, and they therefore have most time to visit UGS on a daily basis, if their health allows this. In this cluster there are both many daily users, but also many non users; which might be explained by the poor health status of some persons. People in this cluster basically only use UGS to go for a walk, often with their dog, and some cycling. The difference between total time in a green environment on weekdays, versus weekend and holiday days is relatively small in this cluster.

Young families with children under the age of six make up the fifth cluster and persons in this cluster are characterised by a family and child oriented use of the nearest UGS. They use the UGS rather frequently, typically a few times a week, and spend quite some time there together with their family and on play activities. The total time spent in green environments increases drastically on weekends and holidays, probably because many people in this cluster have their own garden.

Contrary to the four clusters of park users found by Kemperman and Timmermans (2006a), our clusters do contain socio-demographic characteristics, and this seems to be supported by other studies that find significant difference in the use of UGS based on socio-demographic characteristics of users (e.g. Galloway, 2002; Payne, Mowen & Orsega-Smith, 2002; Tinsley, Tinsley & Croskeys, 2002). In general, segmenting of users of UGS appears to be rather new, and more research in this field is probably relevant.

Different preferences, different green spaces

The five clusters each have their own preferences for how an UGS should look and which qualities it should provide, which is likely to be related to the different activities they like to participate in. Kemperman and Timmermans (2006a; 2006b) came to a similar conclusion in their segmentation studies of park users in Eindhoven, The Netherlands. Experiencing nature and getting away from urban noise and sights is important for respondents in cluster 1 and UGS should have many trees, water elements and a varied plant life. For respondents in cluster 2 lights, lawns and exercise trails and views on water are important desired qualities. Respondents in cluster 3 like BBQ or fire places, and lights and lawns are a good thing too. For cluster 4 lights are among the top priorities and many trees, lawns, a varied plant and animal life, flowerbeds, benches, toilets and signs are also important to many. Play equipment, lawns, many trees and soccer fields are the most desired quality for cluster 5.

Expected demand for UGS in different neighbourhoods

Our comparison of the percentage of respondents belonging to each of the five clusters shows variations for the different neighbourhoods in our study area. It seems that the two larger neighbourhoods, Skibhus and Kragsbjerg, have more variation in residents, and therefore a closer to average distribution among the clusters. For UGS planning purposes it might be useful to subdivide these neighbourhoods into smaller units, which are likely to have a more homogenous group of residents. The expectations towards UGS in Hunderup and Åløkke are likely to be dominated by demands for more natural UGS, with many trees and good trails, whereas the expectations in the Skt Jørgens Gade neighbourhood will probably tend more towards the presence of facilities such as BBQ or fire places, lights, lawns, flowerbeds, benches, toilets and signs. Whether or not the current UGS in these neighbourhoods live up to these expectations lies outside the scope of this study, but would be very interesting to explore in the future.

Discussion of methodology

From a methodological point of view the main strength of the current study lies in the fact that survey included a relatively large number of respondents in a relatively small study area. This meant that each of the five clusters still had a reasonable number of respondents and that cluster memberships could be identified even within smaller neighbourhoods within the study area.

We also see the use of a Latent Class Analysis as an advantage over e.g. K-means clustering as this meant we did not have to violate the required normal distribution, linearity, or homogeneity restrictions. The two studies we found that used latent class cluster analysis to develop segmentation models for the use of urban parks (Kemperman & Timmersmans, 2006a; 2006b) used a factor analysis before clustering, which is, according to Dolnicar and Grün (2009), questionable as it reduces the accuracy of clustering and does not bring advantages over clustering the data directly.

As with all data-driven post-hoc segmentations, there is a risk of misinterpretation (Dolnicar & Grün, 2008) of the results, however, we feel that the five clusters we found, and the behavioural differences between them, also make sense from a phenomenological point of view. E.g. it appears logical that families with young children have a different use pattern and other demands from UGS than students or senior citizens.

A weakness of this study lies in our assumption that the nearest UGS would be the most used UGS for most respondents; we now know that this was a wrong assumption. The assumption was based on the results from earlier studies that report a clear effect of distance on use (Coles & Bussey, 2000; Grahn & Stigsdotter, 2003; Nielsen & Hansen, 2007), and for that reason many of our questions were related to use of the nearest UGS. The behavioural factors included in the LCA were based on participation in activities in the nearest UGS, but we suspect that the type of activities done in the nearest UGS is relatively similar for a user, regardless if the nearest UGS is the most used UGS or not.

All surveys have the risk that those people with a positive attitude towards the topic of the survey, the use of UGS in this case, are more inclined to answer than those with a more negative attitude, which could lead to an overly positive picture of the total population. Due to the relatively high non-response rate (47.8%) of this study, we felt it was necessary carry out a non-response analysis. The analyses showed a slight underrepresentation of persons between 17-29 years old; 35.8% among the respondents versus 39.7% among the sample. It furthermore showed a slight overrepresentation of women among our respondents, 53.6%, compared to 49.2% among the sample. But these differences were not significant (data not shown) and therefore not likely to have had a large impact on our results.

Future research

As mentioned, accessibility to UGS was very good in our study area, and it would therefore be interesting to conduct a similar study in an area with more variation in UGS availability. Furthermore, the five clusters we found can probably be used without too many problems in other larger Danish cities, but it seems questionable that they are as relevant in smaller towns. A study that includes a variation of town and cities, both large and small, will therefore be useful. Finally, this study included only adult respondents and it is likely that younger age groups form one or more clusters of their own.

CONCLUSIONS AND IMPLICATIONS FOR PRACTICE

Is using information on clusters of users of UGS a useful thing to do for city planners and green space managers? Based on the result from this study, the answer seems to be yes. The five clusters of users we found are different with regards to their use of UGS and their preferences. At the same time the clusters are relatively easy to identify among the population, and meaningful differences in the cluster distribution among neighbourhoods can be observed. This means that UGS management and planning could be adapted to meet the specific demands of a given population in a given neighbourhood. Care should of course be taken in using these clusters because in reality all people are different, but working with what five types of ‘average’ persons want is an improvement over working with what just one ‘average’ person wants.

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PAPER V

ASSESSING THE ATTRACTIVENESS OF URBAN GREEN SPACE

Draft manuscript

ASSESSING THE ATTRACTIVENESS OF URBAN GREEN SPACE

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ABSTRACT

Using a sample of 1305 Danish adults and detailed descriptions of urban green space (UGS) an attractiveness model was developed, based on the probability of visiting UGS regularly, at least once a week. Separate distance decay parameters for five types of user of UGS were estimated using an exponential regression model. Coefficients for the effects of the distance and two quality parameters, the number of features and the experience score, were estimated as well. The attractiveness model was used to predict the probability of visiting three UGS, for the five different clusters of users. The results indicate that the five groups of users react differently to distance to and quality of UGS. Students and young couples are more willing to travel further to an UGS with a higher quality than the other groups are. Based on the attractiveness model also the total number of regular visitors to each UGS was calculated, divided by cluster. The results indicate that seniors are less likely to visit high quality UGS that are further from their home than other user groups. The attractiveness model is a promising start but it will need to be developed further before it can be used successfully in practice.

Keywords
City planning, Green space management, Use of UGS, Decay factors, Typology of users.

INTRODUCTION

The importance of providing sufficient green space to the urban population appears to have received renewed attention the past five years. Especially the health benefits associated with the increased use of urban green space (UGS) has raised awareness among both national and local politicians and this has e.g. resulted in the inclusion of green space in health and wellbeing policies (Aarestrup et al., 2007; Public Health Office Copenhagen, 2006). It seems reasonable to assume that increasing the use of UGS would, in theory, increase the health of the urban population. This brings up the question of what it is that influences use, what it is that makes a green space attractive for use. Access, distance, size, presence of facilities, possibilities for activities and presence of desired experiences are mentioned as environmental factors associated with the use of green space (Bedimo-Rung et al., 2005; Björk et al., 2008; Giles-Corti et al., 2005; Van Herzele & Wiedeman, 2003).

The increased political attention is good news for green space managers and city planners, but it also leaves them with the task to ensure that 'their' green spaces deliver the benefits to fulfil the policy aims. This raises a few questions: How attractive is the existing UGS? Which factors influence attractiveness? Is attractiveness the same for all citizens?

In many European cities, norms and standards for green space provision were used in the 1960s and 1970s (e.g. Andersson et al., 1984). In the 1990s, Natural England made the recommendation that everyone in the UK should have access to a green space of at least two hectares within 300 metres of their home (Harrison et al., 1995). The Accessible Natural Greenspace Standards (ANGSt) Model Harrison et al., (1995) developed is still being used, albeit that an evaluation demonstrated that awareness of the model was very low among local authorities in the UK (Handly et al., 2003). The European Environmental Agency (EEA) recommends that people should have access to green space within 15 minutes walking distance (Stanners & Bourdeau, 1995). The empiric scientific basis for the available norms seems to be limited and the quality of a green space is usually not taken into account.

Based on available knowledge on factors influencing the use of urban green space as well as existing planning norms, different models for attractiveness and accessibility of urban green space have been developed, and these models have been used to assess the availability of urban green space. Oh and Jeong (2007) for example, made an elaborate assessment of the spatial distribution of all urban parks in Seoul, South Korea, using norms from the Korean Urban Park Law. They found that the percentage of the population that had sufficient access to a park (as defined by the Korean Urban Park Law) varied between the different parts of the city and was between 33.5% and 75.9%. The attractiveness of a park was not taken into account in this study. Van Herzele and Wiedemann (2003) developed a model to assess the availability and attractiveness of urban green space. This model used a distance decay function based on standards in the Flemish planning norms, and the decay function was adjusted using five parameters for attractiveness; space, nature, culture and history, quietness, and facilities. The method was used in four Flemish cities revealing substantial shortages of smaller green spaces close the residents (city quarter green) as well as an almost total lack of large urban woodlands on the city fringe.

We have only found one study that modelled the attractiveness of urban green spaces based on empirically calculated decay parameters (Giles-Corti et al., 2005). In this Australian study the decay parameters were calculated for individual areas and adjusted for size and attractiveness of each area (Giles-Corti et al., 2005). It seems that the same decay parameters have been used in a study by Hillsdon et al. (2006) in the UK, but applying parameters calculated in Australia in the UK without adaption is questionable as decay parameters are clearly influenced by region and culture (Skov-Petersen, 2001).

Many studies report significant differences in the use of urban green space depending on individual factors such as age, education, gender and ethnicity (Coles & Bussey, 2000; Galloway, 2002; Payne et al., 2002; Roovers et al. 2002; Tinsley et al., 2002; Giles-Corti et al 2005). For that reason we feel that it is necessary to calculate parameters for different groups of users, instead of only looking at the decay parameters for an 'average' person. In this study we use the five clusters of users of UGS have been identified by means of a Latent Class Analysis in Paper IV. The clusters were named after their main characteristics; cluster 1 consists primarily of well-educated families, middle aged (50 years old on average) respondents that rarely have young children. The second cluster is made up by young couples, on average 27 years of age, well educated and typically without children. The third cluster consists primarily of young students (22 years old on average), the majority (64.9%) is female. Cluster number four consists mainly of seniors (60 years old on average) with a relatively low level of education. The last and fifth cluster consists primarily of young families with children under the age of six (96.2%) with an average age of 33 years old. More details on the method used, as well as the identified clusters can be found in Paper IV.

The aim of this study is to develop a model for the attractiveness of UGS in a Danish city, for different groups of users of UGS. More specifically we want to answer the following research questions:

- Which are the decay factors for use of UGS in a Danish city?
- How do the size and quality of an UGS affect the attractiveness?
- Does the attractiveness of an UGS vary for different groups of users?

METHODS

Definitions

Urban green space (UGS) is defined as all publicly owned and publicly accessible open space with a high degree of cover by vegetation, e.g. parks, woodlands, nature areas and other green space. It can have a designed or cultural character as well as a more natural character. Only areas that can be entered by users are included.

Attractiveness of UGS is defined as the probability that residents use an UGS regularly (at least once a week); the higher the chance, the more attractive the UGS.

Use of UGS is defined broadly as any sort of visit to an urban green space, without looking at the duration of the stay, the reason for visiting or the activity done while visiting; e.g. passing through on the way to a destination is also counted as use.

Study area

Odense is the third largest city of Denmark, with a population of 187 929 as of January 2009 (Statistics Denmark 2009), and it was selected as study area because of its image of being a ‘green and active city’ and the availability of detailed information on all UGS. We selected the central part of the city as study area to increase the possibility to generalise the result from this study to other Danish cities, because of the large variation in housing types and UGS types that can be found here. The case study area was created by drawing a circle with a two kilometre radius with the main railway station as central point (see figure 1). The area has approximately 35 000 inhabitants. Within the case study area 53 UGS can be found. These UGS range from small neighbourhood parks, historic gardens, recreation areas, to urban woodlands. To get more detailed information on the use of UGS and to get an impression of how the same people use different UGS, 10 UGS were selected for a more detailed analysis based on variation in size, character and location.

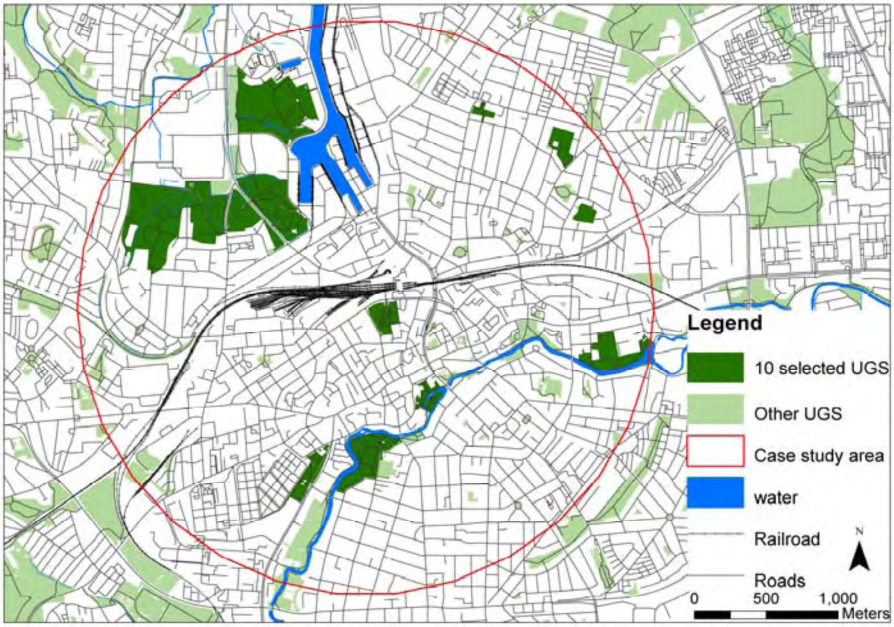

Figure 1. Study area with the 10 selected UGS and all other accessible UGS.

Data: Use of UGS

Within the study area the Municipal Statistics Department in the city Odense randomly selected 2 500 residents aged 18-80 and an 18-page postal questionnaire was sent to them in October 2005. The response rate was 52.2% (n = 1 305) after sending two reminders. Non-response analyses showed some small differences for age and gender, but they were not significant (data not shown) and therefore not likely to have had a large impact on our results.

The questionnaire used in this study was inspired by questionnaires used in earlier surveys (Grahn & Stigsdotter, 2003; Nielsen & Hansen, 2007; Tyrväinen et al., 2007). The feedback on a preliminary version of the questionnaire that was sent to a selected group of respondents, who were not part of the sample, was incorporated in the final version of the questionnaire. The Danish Data Protection Agency approved the survey.

The respondents were, among other, asked about the frequency of use of each of the 10 UGS between April and October on a 6-point scale (never, seldom, 1-3 times a month, 1-3 times a week, 4-5 times a week, daily). The survey also included questions on motivation for visits, activities and possible constraints for visiting, for each of the 10 UGS. Finally, background factors such as age, gender, level of education, income, type of residence and number of children were included in the questionnaire. All respondents were assigned to one of five clusters: well-educated families, young couples, students, seniors and young families. The addresses of all respondents have been added as anonymised address points in a GIS and the questionnaire data was then linked to each address point.

Data: Size of and distance to each UGS

The size of each UGS was derived directly from the GIS based green space management information system that is used by the Municipality of Odense. All entrances to the UGS were added to a new GIS layer based on the municipal data, and verified during field visits. The distance from each respondent to the nearest entrance to each UGS was calculated with the ArcGIS Network Analyst using a network dataset with all roads and trails accessible for pedestrians and cyclists available from The National Survey and Cadastre Agency of Denmark. This method has been shown to be a more precise measure for UGS proximity than using Euclidian distances (Oh & Jeong, 2007; Lee & Moudon, 2008).

Data: Features present in each UGS

The Environmental Assessment of Public Recreation Spaces (EAPRS) instrument developed by Saelens et al. (2006) was used to assess the presence of features as this tool was tested and found reliable (Saelens et al., 2006; Kaczynski et al., 2008). The quality assessments that are also part of the EAPRS tool were not included as these were reported to be less reliable (Saelens et al., 2006). The presence or absence of 39 features, based on the main categories used in the EAPRS, was assessed in all UGS in study area. Giles-Corti et al. (2005) found the presence of lights along at least one trail to be an important feature and this was added as a separate category and became feature number 40. A full list of features can be found in Paper III. The total number of different features present in each UGS was calculated, and could be a maximum of 40 for each UGS.

Data: Experiences score for each UGS

Some studies, e.g. Scott et al. (2007), report that perceived environmental factors are better predictors for behaviour than objectively measured environmental factors. McCormack et al. (2004) argue for more studies that combine subjective and objective assessment methods of environmental features as the discussion on whether subjective or objective environmental assessments are to be preferred is very much ongoing. We followed this advice and recorded the presence of subjective experiences in each UGS. The method we used is based on experiences developed by Grahn & Stigsdotter (in press) and was further developed into a practical tool by Randrup et al.

(2008). The validity and reliability of the tool have not yet been tested scientifically. The tool consists of two steps; firstly rooms are identified within each UGS, and secondly within each room the presence of eight different experiences is recorded. If an experience is present, it is classified as either weak (1), medium (2) or strong (3). The eight experiences are: wild, cultural-historic, prospect, festive, space, rich in species, refuge and serene. The total number of different experiences present in each UGS, multiplied with the maximum strength of each experience in each UGS, was calculated based on the assessment scores, giving a theoretical maximum experience score of 24 for each UGS.

Assessing the attractiveness of UGS

Assessing the attractiveness of an UGS can been done in different ways (e.g. (Giles-Corti et al., 2005; Hillsdon et al., 2006; Van Herzele & Wiedemann, 2003); we have included distance and size, and we assume that the quality of the area can be expressed by the number of features present, and the number and strength of the experiences present. We have chosen to assess attractiveness by estimating the probability that a random resident belonging to one of the five clusters visits a certain UGS at least once a week. In mathematical terms this is described in equation 1.

Before estimating the probability of visiting a given UGS at least once a week, distance decay parameters were estimated for each of the five clusters. The network distance (in metres) between the origins (the respondents home) and the destination (the nearest entrance to each of the 10 UGS) was used in an exponential distance decay model in SAS. In order to generate parameters that were in the same order as the other coefficients, distance was divided with 1000. After estimating the distance decay parameters, all other coefficients in the attractiveness model were estimated using a logistic regression procedure in SAS.

RESULTS

Estimating the distance decay parameters

The distance decay parameters for the five clusters were estimated in an exponential decay model, and the results can be seen in table 1. A smaller parameter indicates a higher sensitivity to distance, which means that the seniors are most sensitive to distance when it comes to visiting one of the 10 UGS at least once a week. Young families on the other hand are the least sensitive to distance. The other three clusters have a relatively similar decay parameter.

$$p_{visit} = \frac{\exp(z)}{1+\exp(z)}$$

$$z = \alpha + \beta\ Feature + \gamma\ Experience + \delta\ Size + \varepsilon . f(distance)$$

$$p_{visit} = \frac{\exp(\alpha + \beta\ Feature + \gamma\ Experience + \delta\ Size + \varepsilon . f(distance))}{1+\exp(\alpha + \beta\ Feature + \gamma\ Experience + \delta\ Size + \varepsilon . f(distance))}$$

Where
α = a constant, per cluster
β = coefficient for the feature score, per cluster
γ = coefficient for the experience score, per cluster
δ = coefficient for the size, per cluster
ε = coefficient for the distance, per cluster
And

$$f(distance) = \phi_{cluster}^{distance/1000}$$

Where
ϕ = the distance decay parameter, per cluster

Equation 1. General model for the probability of a given person within a given cluster visiting an UGS with particular characteristics.

Table 1. Distance decay parameters per cluster

Cluster	Well-educated families	Young couples	Students	Seniors	Young families
Distance decay parameters	0.46	0.42	0.46	0.37	0.62

Extrapolation of results to all residents in the study area

To be able to create an attractiveness surface for the entire study area we needed to extrapolate the results of our survey respondents to the whole population in the study area. This extrapolation was done using population data that is available from Statistics Denmark for points laid out in a 100*100 metre grid. To include the effect of the different clusters, we included the distribution of the population over the five clusters. For all points within the seven neighbourhoods shown on figure 2, their specific distribution was used, see table 2. For the points outside these neighbourhoods the average distribution of the population over the clusters in the study area was used.

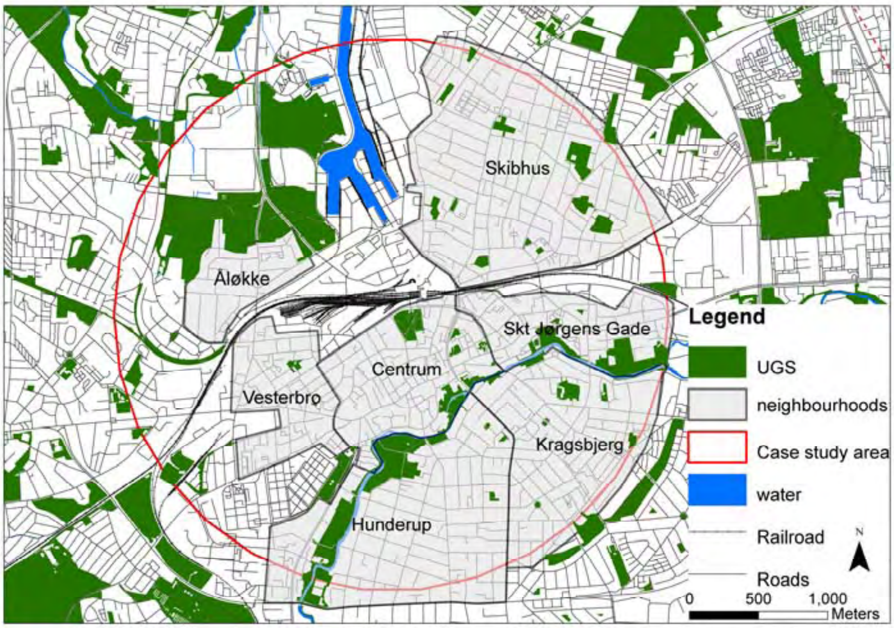

Figure 2. Study area with all accessible urban green spaces and seven neighbourhoods.

Table 2. Allocation of the five clusters of users of urban green space in different neighbourhoods. In % of respondents in each neighbourhood.

Neighbourhoods	Well-educated families	Young couples	Students	Seniors	Young families	
	% of population in each neighbourhood					*n*
Hunderup	47.1	20.2	13.5	6.7	12.5	104
Kragsbjerg	31.0	28.4	17.2	11.8	11.5	348
Skt Jørgens Gade	30.9	22.2	19.8	17.3	9.9	81
Centrum	29.4	24.8	14.4	19.0	12.4	153
Vesterbro	25.7	27.8	16.7	16.7	13.2	144
Åløkke	45.3	11.3	17.0	11.3	15.1	53
Skibhus	32.8	20.1	14.3	17.4	15.4	293
Average	33.2	23.2	15.5	15.1	12.9	1229

The final attractiveness model

When we started estimating the probabilities of visiting an UGS using the model described in equation 1, it turned out that there were significant interaction effects between size and number of features and experience score. Size was not a significant factor in the final model. This was not entirely unexpected as Giles-Corti et al. (2005) and Kaczynski et al. (2008) also found a correlation between size and the number of features. We removed all non-significant parameters from the model, resulting in the final attractiveness model shown in equation 2.

$$p_{visit} = \frac{\exp(z)}{1+\exp(z)}$$

$$z = \alpha_0 + \alpha_{cluster} + (\beta_0 + \beta_{cluster})\,Feature + \gamma\ Experience + (\varepsilon_0 + \varepsilon_{cluster})\ f(dis\tan ce)$$

$$p_{visit} = \frac{\exp(\alpha_0 + \alpha_{cluster} + (\beta_0 + \beta_{cluster})\,Feature + \gamma\ Experience + (\varepsilon_0 + \varepsilon_{cluster})\ f(dis\tan ce))}{1+\exp(\alpha_0 + \alpha_{cluster} + (\beta_0 + \beta_{cluster})\,Feature + \gamma\ Experience + (\varepsilon_0 + \varepsilon_{cluster})\ f(dis\tan ce))}$$

Where
α = a constant, per cluster
β = coefficient for the feature score, per cluster
γ = coefficient for the experience score
ε = coefficient for the distance, per cluster
And

$$f(dis\tan ce) = \phi_{cluster}^{dis\tan ce/1000}$$

Where
ϕ = the distance decay parameter, per cluster (see table 1)

Equation 2. Final model for the probability of a given person within a given cluster visiting an UGS with particular characteristics.

There were interaction effects between the clusters and features and distance, whereas there was no interaction between experiences and clusters. This indicates that respondents in the five clusters react relatively similar to the presence of experiences, whereas they assign different importances to the presence of features and distance. The estimates for all coefficients in the model can be found in table 3. The values of   are all zero for young families (cluster 5) so in practice   are the values for young families.

Table 3. Estimated model coefficients for the final attractiveness model

Coefficient	Cluster	Estimate				
α_0		-7.63				
α_1	Well-educated families		0.97			
α_2	Young couples			-0.60		
α_3	Students				-0.80	
α_4	Seniors					1.85
β_0		0.22				
β_1	Well-educated families		-0.04			
β_2	Young couples			0.07		
β_3	Students				0.08	
β_4	Seniors					-0.07
γ		-0.10				
ε_0		5.40				
ε_1	Well-educated families		0.21			
ε_2	Young couples			-1.11		
ε_3	Students				-1.06	
ε_4	Seniors					-0.27

Probability of visiting an UGS

The estimated coefficients (table 3) were entered in the final model shown in equation 2 to estimate the probability of visiting each of the 53 UGS at least once a week for respondents in each of the five clusters. The probability for an average person was estimated by summing the probabilities for the five clusters, and dividing the result by five. Based on the model, probability surfaces were drawn for the entire study area, using the population data available for each point in a 100*100 metre grid. Areas without inhabitants, e.g. industrial areas, were excluded from the extrapolation.

To exemplify the possibilities of the attractiveness model we selected three different UGS, located in different neighbourhoods of our study area. The selected areas vary in size, character and location, and give an impression of the total diversity of UGS in the study area. Munke Mose is a centrally located city park that was established around 1912 in landscape style and today it is characterised by many large trees, of numerous species, large lawn areas, and a popular playground. The area has several large ponds and overlooks the stream that runs trough the city. Fredens Anlæg is a small park located in the Skibhus neighbourhood. The park has a small, recently renovated, playground, a lawn area and mature trees. Åløkke Skov is a large more natural area dominated by mature woodland, but also including some meadows and a wetland area. There is a playground and there are facilities for the local scouting group and nature education groups. The area is relatively hard to reach as the railway and the harbour act as barriers for many citizens, but it is at the same time the woodland area located closest to the city centre. Table 4 provides and overview of the size, number of features and number of experiences in the three UGS. Munke Mose and Åløkke Skov are comparable with regards to the number of features and experiences that are available in the areas, however very different in expression. Fredens Anlæg appears to have a relatively high number of features and experiences, considering its limited size.

Table 4. Characteristics of three selected UGS

Area-name	Size (ha)	Number of features	Number of experiences
Munke Mose	8.0	22	12
Fredens Anlæg	1.0	11	5
Åløkke Skov	44.9	21	14

PROBABILITY OF VISITING AN UGS

In figure 3 the average probabilities of visiting the three different UGS can be seen. Clear differences can be seen for the attractiveness of the three UGS. The centrally located Munke Mose has a large catchment area, and the probability of visiting this area regularly is 10% or more for almost all residents in the study area. For smaller areas, like Fredens Anlæg, the catchment area is clearly much smaller, and also the average probability is lower. For Åløkke Skov the catchment area seems to be slightly smaller than for Munke Mose, however it is important to remember that a substantial part of the catchment area of Åløkke Skov lies outside the study area. The probability of visiting Åløkke Skov for inhabitants living in the southern part of the study area is close to zero.

PROBABILITY OF VISITING AN UGS, PER CLUSTER

In figure 4a-c the probabilities of visiting the three different UGS can be seen for each of the five clusters. Clear differences between the clusters can be seen; well-educated families and in particular seniors are less willing to travel further for more attractive UGS. Students, young couples, and to some extent also young families, are more willing to travel to an UGS with more features and experiences. The probabilities of visiting Åløkke Skov and Munke Mose are relatively high (over 0.5) for all citizens living within 300-400 metres of these UGS. However, for Fredens Anlæg only well-educated families living very close by (<100 metres) have a probability over 0.5. For young couples and students, the maximum probability is only 0.25 for those persons that live within 300-400 metres of Fredens Anlæg.

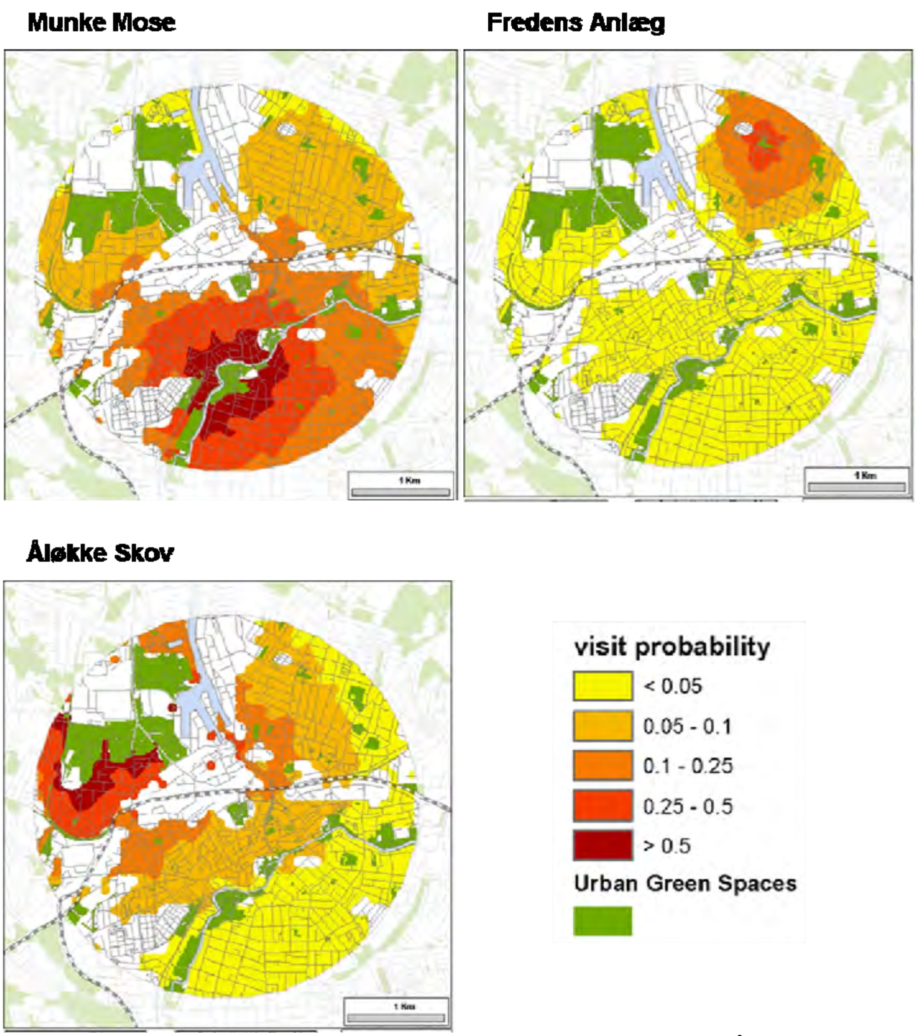

Figure 3. Probability of visiting Munke Mose, Fredens Anlæg, and Åløkke Skov, for an average person living in a random grid point.

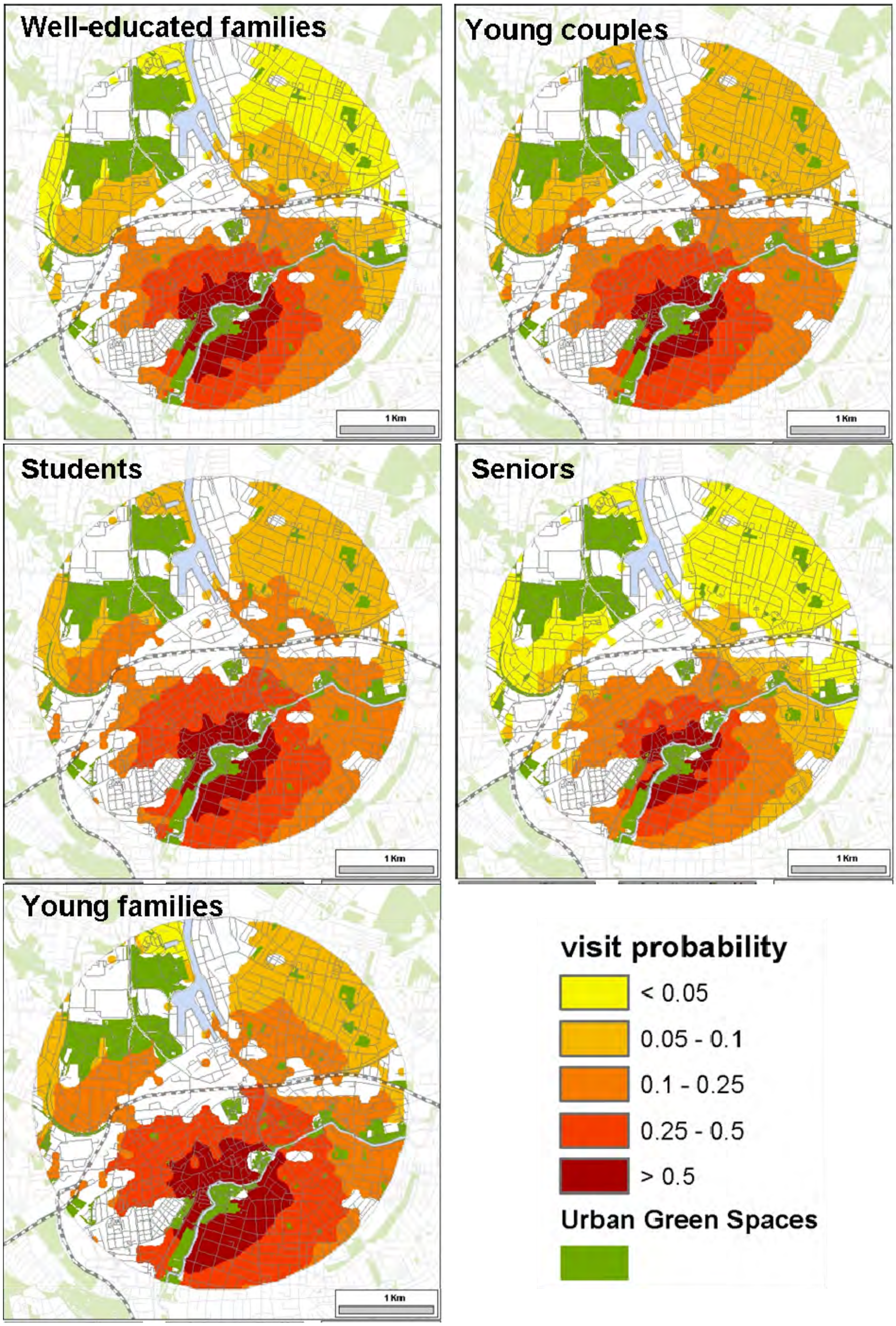

Figure 4a. Probability of visiting Munke Mose for each of the five clusters.

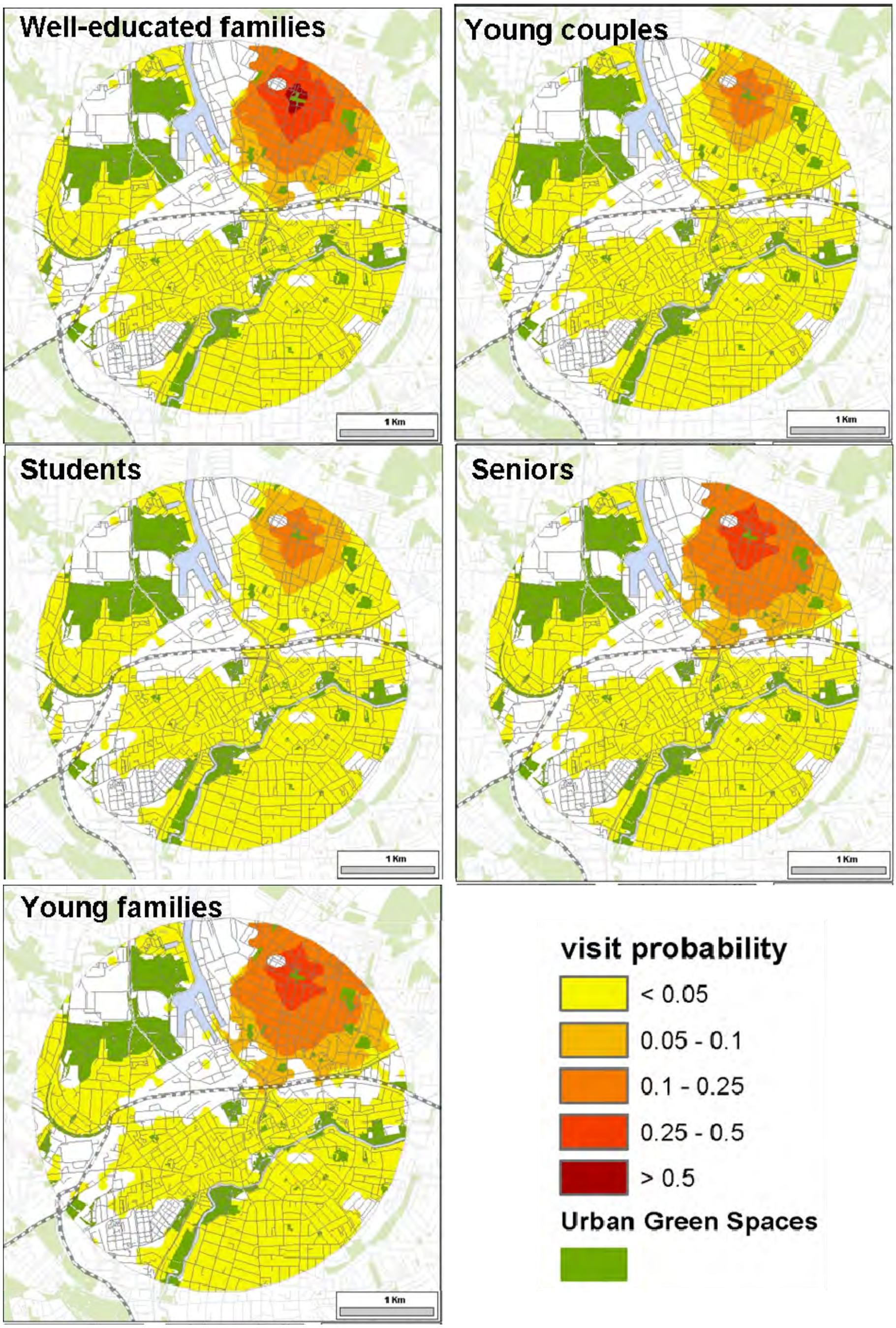

Figure 4b. Probability of visiting Fredens Anlæg for each of the five clusters.

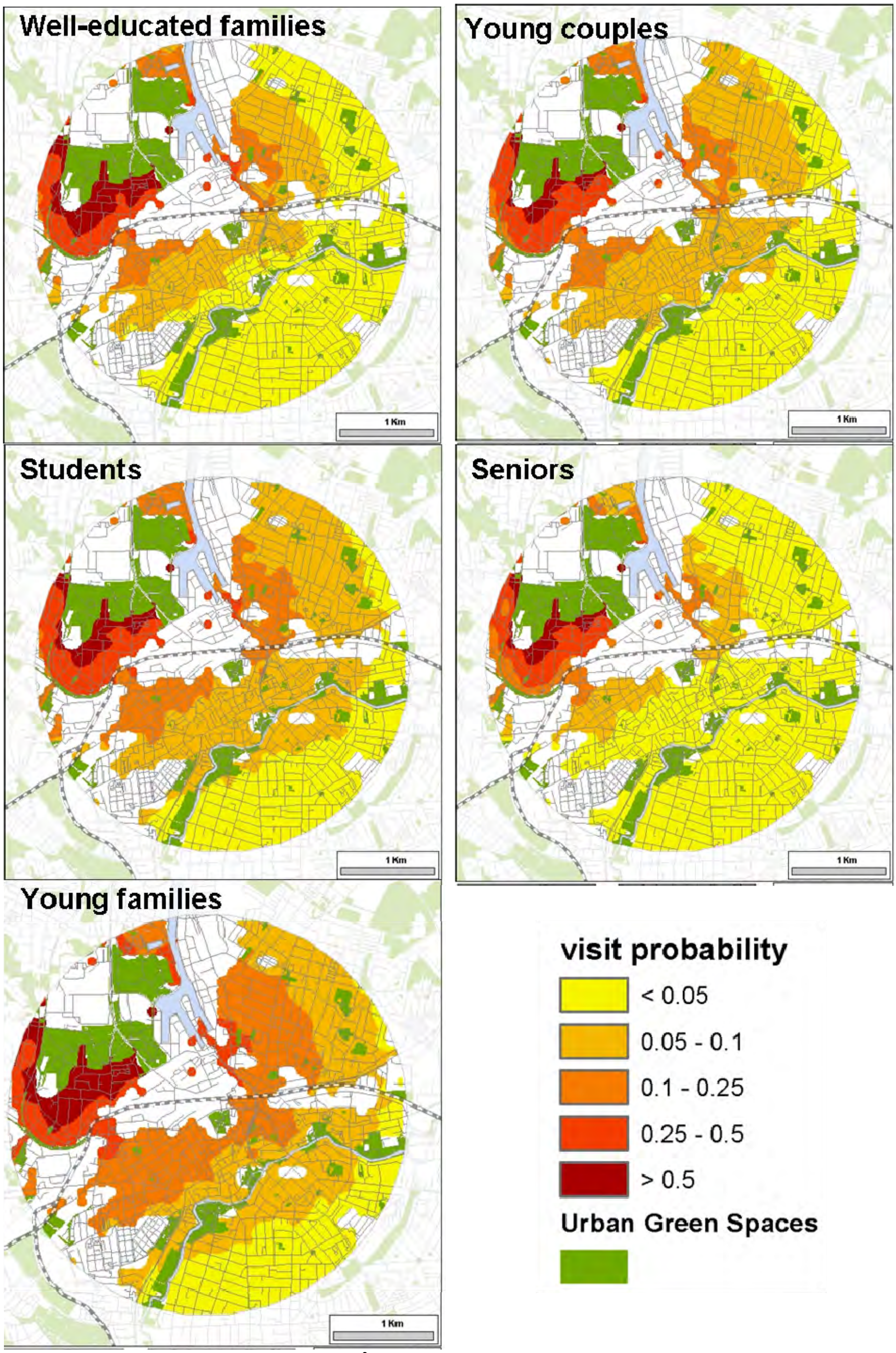

Figure 4c. Probability of visiting Åløkke Skov for each of the five clusters.

Total number of weekly visits to a single UGS, divided by cluster

When we combined the probability of visiting a certain UGS for a person in a cluster with the number of persons belonging to each cluster living in each population point, we could estimate the total number of visits to each UGS, both in total and divided by cluster. Table 5 shows the absolute and relative number for Munke Mose, Fredens Anlæg and Åløkke Skov, both in total and per cluster. Munke Mose is clearly the area with the highest number of visitors, but some caution should be taken when looking at the numbers for Åløkke Skov, as this area is close to the boarder of the study area, and the 'edge-effect' is not accounted for in our model. For that reason it is probably more interesting to look at the relative numbers per cluster for the three different areas. For example, seniors are underrepresented as visitors in Åløkke Skov and Munke Mose, they make up 9.0-9.9% of the visitors while they on average constitute 15.1% of the population (table 3). For Fredens Anlæg, seniors are overrepresented with 20.8%. Many young families seem to be frequent users of UGS, they are overrepresented in all three areas; 12.9% of the population versus 16.5-18.1% of the visitors that come at least once a week.

Table 5. Number and percentage of visitors that visit three UGS at least once a week, per cluster and in total.

	Well-educated families	Young couples	Students	Seniors	Young families	Total
Area-name	Number of visitors that visit at least once a week					
Munke Mose	4299.4	3366.3	2512.9	1236.2	2249.3	13664.1
Fredens anlæg	951.1	254.5	194.2	475.7	412.7	2288.2
Åløkke skov	2131.0	1652.5	1348.7	706.4	1287.9	7126.4
	% of total number of visitors					
Munke Mose	31.5	24.6	18.4	9.0	16.5	100
Fredens anlæg	41.6	11.1	8.5	20.8	18.0	100
Åløkke skov	29.9	23.2	18.9	9.9	18.1	100

DISCUSSION

Attractiveness of UGS

We assumed that the distance to, size of, number of features present and the experience score of an UGS would be four environmental factors that would influence the attractiveness of UGS. We also assumed that the probabilities of visiting an UGS regularly would differ for the five clusters of users. In our final regression model distance, the number of features, and the experience score turned out to be significant, as did the different clusters. However, size was not significant, and therefore not part of our final model. This corresponds with finding by Kaczynski et al. (2008), but contradicts with findings by Giles-Corti et al. (2005). Both these studies found correlations between size and the number of features, but apparently it depends on the situation which of the two factors is a significant predictor for behaviour.

Our final model shows a slight negative effect of the experience score on attractiveness, which is surprising at first, but might be explained by the fact that the eight experiences we assessed are very different from each other, and some of them are not always perceived as positive (Grahn & Stigsdotter, in press). For example, the presence of the festive might have a negative effect on the attractiveness for visitors that are looking for a wild or serene experience, and vice versa. Taking this into consideration, the use of the experience score as indicator for the quality of an UGS does not seem to be a good choice in this case. It would be interesting to explore the preferences for the different experiences more, and experiment with an experience indicator that includes preferences.

The results of this study do not directly point in that direction, but in theory, a similar assumption could be made for the number of features; some features might affect the attractiveness in a positive way, while others might have the opposite effect. The results of Paper III have shown that the most preferred features were positively related with being physically active in UGS, which might indicate that including preferences might also be useful when constructing an indicator for quality based on the presence of features.

Attractiveness of UGS for different groups of users

We included the five clusters in our model for attractiveness as we expected different types of users to respond differently to the environmental factors that could affect the use of UGS. This assumption turned out to be correct and we found interaction effects between the five clusters and the number of features, as well as the distance to an UGS. The clusters also each have a different ‘constant’ in the model, which indicates that their use of UGS is different even if all environmental factors are the same. Young couples and students are most likely to travel further to an UGS that has more features, but their overall use of UGS is lower than that of the other clusters. Seniors and well-educated families appear to be the least sensitive for the number of features and the experience score.

Estimating the total probability of visiting UGS at least once a week

In theory, our model could be used to calculate the total probability of visiting UGS, per cluster and for the average person. We did attempt to do so, but we quickly realised that the so-called edge effect would be too large with the current setup. Information on the attractiveness of all UGS in a two kilometre radius around the study area would need to be assessed for features and experiences to be able to estimate the true probability of visiting UGS within the study area.

Furthermore, the model could be used to detect shortages of certain types of UGS, similar to the model by Van Herzele and Wiedemann (2003) who e.g. revealed substantial shortages of smaller green spaces close the residents (city quarter green) as well as an almost total lack of large urban woodlands on the city fringe.

Discussion of methodology

We used a range of methods and data in this paper, and combining them all can on the one hand be seen as strength as this enabled us to model the attractiveness of UGS in great detail. However, at the same time it has made the attractiveness model complex and difficult to use in practice. Especially the collection of data on the available experiences, and to certain extent the available features, is time consuming. Both the experiences score and the number of features present are correlated with the size of an UGS, and in our model size was no longer was a significant parameter. In practice, data on the size of UGS is much easier to collect and we therefore plan to test an attractiveness model that includes size instead of experiences and features. Exploring the relation between size, experiences and features in more detail would also be useful.

CONCLUSIONS AND IMPLICATIONS FOR PRACTICE

The results of this study have shown that it is possible to develop a model that described the attractiveness of UGS, for different groups of users. Our model needs further improvement before it can be used successfully in practice, but some conclusions can be drawn already. Smaller UGS with fewer features and fewer and/or weaker experiences appear to be less attractive for younger, more active users whereas they are visited more frequently by middle aged and older users. For larger, more centrally located UGS with a large number of features and experiences the pattern appears to be opposite; younger active users make up a large part of the total number of regular visitors, whereas middle aged and senior users are underrepresented.

Based on an attractiveness model, UGS planners could make predictions as to where the demand and supply of UGS do not match well, and where changes would benefit many potential users of UGS. It might also be possible to derive planning norms and standards from the model, e.g. specifying a minimum acceptable probability for a young family to visit an UGS. Ultimately, an attractiveness model like the one developed in this paper might help to improve the use of UGS by revealing shortages, and miss-matches between demand and supply of UGS.

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